“Corporate governance, sustainability bonds, and labor costs in promoting green investment”

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CORPORATE GOVERNANCE, SUSTAINABILITY BONDS, AND LABOR COSTS IN PROMOTING GREEN INVESTMENT

Abstract

Green investment is crucial in supporting the transition to a sustainable economy, yet the internal factors driving it remain poorly understood. This study examines the influence of corporate governance (CGI), sustainability bonds, and labor costs on green investment in manufacturing firms in Indonesia. Using 779 observations (firm-years), the analysis employed a panel regression model and a moderation test for capital expenditure (CapEx). The results show that CGI significantly positively affects green investment, highlighting the importance of strong governance in supporting sustainability practices. The implementation of effective corporate governance can replace tunnelling practices and direct corporate funds toward environmentally friendly investments. Sustainability bonds also have a significant positive impact, reflecting the development of green financial instruments in Indonesia. The existence of sustainable bonds provides investors with confidence that their funds are channeled toward sustainable goals, while also helping companies reduce funding costs and accelerate the growth of green investments. Labor costs exhibit a significant positive effect, indicating that firms with higher labor costs are more likely to adopt green technology-based efficiency measures. The moderation test found that CapEx strengthens the relationship between CGI and green investment, indicating that capital expenditure can be a strategic channel for realizing governance commitments to sustainable investment.

Keywords green investment, corporate governance, sustainability bonds, labor cost, capital expenditure, green finance

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INTRODUCTION

In the past two decades, sustainability issues have increasingly taken center stage on the global economic development agenda. Climate change, environmental degradation, and the need to reduce carbon emissions drive both developed and developing countries to shift their investments toward more environmentally friendly options. Indonesia faces challenges similar to those of other countries with significant manufacturing bases in Southeast Asia. Manufacturing contributes significantly to Gross Domestic Product (GDP) and greenhouse gas emissions. The pressure to transform toward sustainable production practices makes green investment crucial in addressing these challenges. However, implementing green investment in Indonesian manufacturing firms still faces serious obstacles, both within the corporation and within the financial system that supports it.

Limited financial resources, regulatory uncertainty, and weak market incentives often hamper green investment in Indonesian manufactur-

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ing firms. Many firms still view green investment as an additional burden rather than a long-term strategic opportunity. Although the government has encouraged green financing through sustainability bond schemes and sustainable finance programs, these instruments have not had a significant impact on increasing green investment in the manufacturing sector. This raises an important question: what factors are the main drivers of green investment in firms, and how do corporate governance, sustainability bonds, and labor costs relate to this?

Corporate governance plays a crucial role in driving sustainability-oriented strategic decision-making. Companies with good governance are believed to be better able to internalize environmental risks in their investment policies. Effective governance enhances managerial accountability, minimizes conflicts of interest, and strengthens compliance with environmental regulations. Therefore, the Corporate Governance Index (CGI) is often considered a relevant predictor of the extent to which a company adopts green investment practices. However, empirical evidence in Indonesia remains limited, necessitating further research to determine the extent to which corporate governance truly influences green investment decisions. Beyond governance factors, transparent investment disclosure allows stakeholders to assess a company's commitment to green practices, enhances corporate reputation, and expands access to low-cost capital. The practice of disclosing information related to green investment is still relatively new and has not yet become a binding standard for manufacturing companies in Indonesia. The challenges of adopting green investment in the Indonesian manufacturing sector demonstrate the need for a multidimensional approach encompassing governance, transparency, operational costs, and sustainable financial support. This research is expected to provide a clearer empirical picture of the determinants of green investment in Indonesia and to serve as a reference for formulating more effective corporate policies and strategies to encourage sustainable development.

1. LITERATURE REVIEW

This study is based on legitimacy theory, which emphasizes that firms must operate according to social norms, regulations, and public expectations to maintain operational sustainability (Deegan, 2019). Green investment is seen as a way for firms to gain social legitimacy, particularly in the context of increasing environmental awareness. Green investment encompasses various activities, from developing environmentally friendly technologies and more efficient waste management to renewable energy projects. Through these investment decisions, firms improve operational performance and signal to the public that they are committed to sustainable business practices. Research by Zheng and Jin (2023) shows that green investment can reduce a company's carbon emission intensity, thereby contributing to environmental legitimacy from the perspective of the public and regulators. Thus, green investment decisions are not simply economic choices but also legitimizing strategies to maintain a social license to operate.

Legitimacy theory explains that firms respond to external pressures from regulation and public oversight by increasing their involvement in green investment. Government environmental audits encourage firms to increase green investment to maintain regulatory legitimacy (L. Sun et al., 2025). Similarly, another study found that establishing environmental legal institutions can disrupt collusion in environmental governance and encourage firms to engage in green innovation (Gao et al., 2024). This evidence suggests that legitimacy is not only a social dimension but is also closely related to compliance with environmental laws and regulations. Legitimacy is the underlying explanation for why better governance structures encourage firms to invest in green projects. Strong corporate governance can reduce financing constraints, thereby increasing investment efficiency, including in environmentally oriented projects (Q. Li et al., 2024). In other words, effective governance enables firms to respond to legitimacy demands by providing an institutional framework that supports green investment. This perspective is also supported by research that finds that new environmental regulations in China strengthen the relationship between corporate governance and green investment decisions (Mei & Zhang, 2025).

This research is also based on agency theory, which explains the potential for conflicts of interest between management and shareholders. Managers tend to maximize their personal interests, including delaying high-risk investments such as green investments. However, good corporate governance practices can minimize agency problems, ensure transparency, and encourage management to consider the company's long-term interests (Q. Li et al., 2024). This research also uses the resource-based view (RBV) theory, which argues that a company's ability to integrate internal resources, such as a skilled workforce, is a key factor in successfully implementing a green strategy. Labor costs and skills that support environmentally friendly technologies influence a company's ability to adopt green investment practices (Q. Ding et al., 2023).

Corporate governance plays a crucial role in determining the direction of investment strategies, including a company's decision to invest in sustainable or environmentally friendly projects. Effective governance mechanisms encourage management to focus beyond short-term profits and consider social demands, regulations, and investor expectations regarding sustainability (Salvioni et al., 2016). Corporate governance creates an institutional framework that guides firms to adapt to external pressures by increasing green investment. Good governance will increase accountability and transparency in strategic decision-making. An independent board of directors and a strong internal oversight system encourage managers to allocate resources to green investments that align with the long-term interests of shareholders and other stakeholders. Strong corporate governance can reduce tunneling practices and increase firms' propensity to make environmental investments for long-term legitimacy protection (Q. Li et al., 2024). Effective corporate governance can also reduce financing constraints. Firms with good governance are more trusted by financial institutions and investors, thus gaining greater access to funding sources, including green financing. Previous research shows that ESG performance and good governance are positively related to corporate investment efficiency because they can reduce risk and the cost of capital (W. Li et al., 2024). This logic explains that governance encourages green investment by increasing credibility and access to green financing.

Corporate governance mechanisms will help manage environmental and reputational risks. Firms with boards sensitive to sustainability issues will be more proactive in making green investments to anticipate litigation risks, regulatory sanctions, and consumer boycotts. Government environmental audit interventions encourage firms to strengthen green investments, and this response is more effective when supported by an accountable governance structure (L. Sun et al., 2025). Thus, governance mediates between regulatory pressures and green investment decisions. Corporate governance is also a strategic legitimacy mechanism through board oversight, environmental committees, and information disclosure. Firms strive to build an image that aligns with global sustainability norms. Corporate governance positively influences the quality of environmental disclosure, strengthening public trust in a company's green commitments (J. Sun et al., 2025). Governance drives green investment decisions internally and ensures that these investments are recognized externally as fulfilling social legitimacy.

Green finance has emerged as a key instrument in encouraging environmentally friendly investments through green bonds, sustainable loans, and ESG-based financial instruments (Raman et al., 2025). Green finance can reduce firms' financing barriers when investing in sustainable projects. This aligns with legitimacy theory, where access to green financing provides cheaper capital and enhances a company's reputation and legitimacy in the eyes of investors, regulators, and the public. Green finance can alleviate financing constraints and improve the efficiency of firms' environmental investments, particularly in sectors with high capital requirements (W. Li et al., 2024). This finding aligns with Ding et al. (2023), who emphasize that digital green financing expands firms' access to capital and, in turn, strengthens the realization of sustainable investments. In other words, green finance serves as a catalyst that bridges capital constraints with opportunities for green project implementation.

Another study demonstrated green investments facilitated by green financing significantly reduced a company's carbon emission intensity, ultimately strengthening competitiveness and mitigating

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reputational risk (Zheng & Jin, 2023). Research by Mei and Zhang (2025) also found that environmental regulations encourage green finance flows to accelerate firms' transition to green investments while reducing compliance costs with government policies. This confirms that green finance is not merely a financing instrument but also part of a company's strategy to meet external expectations and maintain long-term legitimacy. Green finance plays a crucial role in encouraging green investment by reducing financing constraints and providing more affordable access to capital, enabling firms to allocate funds to sustainable projects that were previously unaffordable due to financial constraints (Q. Ding et al., 2023; W. Li et al., 2024). Green finance also strengthens the link between governance, disclosure, and green innovation, enabling green investment to occur not only due to regulatory pressure but also due to strategic opportunities to generate long-term added value (Gao et al., 2024; L. Sun et al., 2025). Therefore, green finance positively impacts green investment by acting as a financing catalyst, legitimizing mechanism, and driving innovation, supporting firms' transition to sustainability.

The role of labor costs in encouraging or inhibiting green investment has been a key topic in the literature on environmental economics and sustainable finance. One key argument is that the transformation to a green economy has structural consequences for the distribution of labor income, production costs, and corporate investment decisions. Previous research has shown that green tax reforms in China shifted the burden of environmental costs to firms, resulting in a decline in the labor share of income (Wei et al., 2023). This indicates that increasing environmental costs reduces firms' capacity to maintain labor cost efficiency, ultimately impacting investment strategies, including environmentally friendly investments. Green factory development tends to reduce the labor share of income, suggesting a trade-off between environmental spending and worker well-being. In the long run, such investments improve operational efficiency and firm competitiveness (Wei et al., 2024). The application of artificial intelligence in green production can also increase green total factor productivity by changing the skill structure of the workforce, so that high labor costs can be offset by increased productivity (Yang & Kuang, 2025). This is reinforced by other research that confirms that increased labor productivity is key to green growth, as it allows firms to reduce labor costs relative to green output (X. Yu et al., 2024). Thus, while high labor costs can pressure firms, increased productivity can mitigate their negative impact on green investment.

High labor costs can be a barrier because they increase total production costs, reduce investment flexibility, and reduce workers' share of income in the short term (Lee et al., 2025; Wei et al., 2023). High labor costs can also encourage firms to adopt labor-saving green innovations and increase productivity, thus becoming a driver of green investment in the long term (Farooq et al., 2025; Rughi et al., 2025). Therefore, labor costs can encourage firms to make green investments to increase productivity, increasing company revenue, thereby reducing the proportion of the burden of a company's operational costs. By understanding these dynamics, it is important to examine the factors that drive green investment decisions. This study aims to obtain empirical evidence on the influence of corporate governance, sustainability bonds, and labor costs on green investment in manufacturing companies in Indonesia.

2. METHODOLOGY

This study uses a quantitative approach to empirically test the influence of the corporate governance index, access to green finance, and labor costs on green investment in manufacturing firms in Indonesia. The unit of analysis is manufacturing firms listed on the Indonesia Stock Exchange (IDX) from 2020 to 2024. Data begins in 2020 due to the start of firms' sustainability reporting and the upcoming implementation of green finance policies in Indonesia. Therefore, most of the available green finance data begins in 2020.

The data used is sourced from annual financial reports and sustainability reports. The dependent variable, green investment (LnGI), is measured using the natural logarithm of a company's total investment allocated to environmentally friendly assets or sustainability-oriented projects (Erdogan, 2024; Gao et al., 2024; J. Li & Liu, 2025). The independent variables consist of the corporate gov-

ernance index (CGI), constructed from aggregate scores on board composition, independent ownership, audit committee size, and managerial transparency (J. Li, 2025; J. Sun et al., 2025); green finance (sustainability bonds/SB), measured by the total value of green bonds issued by the company (Dzomonda, 2022), and labor costs (LnLC), represented by the natural logarithm of total annual labor costs (Jin et al., 2024; Mazumder & Rao, 2023).

The empirical model in this study is estimated using a multiple linear regression approach of table data, referring to the following econometric equation:

$$LnGI_{it} = \alpha + \beta_1 CGI_{it} + \beta_2 SB_{it} + \beta_3 LC_{it} + \delta FIRM_{it} + \gamma MAKRO_t + \varepsilon_{it}, \quad (1)$$

where *LnGI* is green investment, *CGI* is Corporate Governance Index, *SB* is Sustainability Bond, *LC* is Labor cost, *i* is company, *t* indicates time subscript, α is intercept, β_1, β_2, β_3 are coefficients of each explanatory variable, δFIRM is a vector of firm specification control variables (SIZE, ROA, Institutional Ownership, Debt, and Liquidity), γMACRO is a vector of macroeconomic control variables (GDP), and ε is standard error.

This study uses panel data regression analysis to test the research hypotheses. The best model estimation is determined based on a comparison of probability values, whether common effects, fixed effects, or random effects. Classical assumptions are also checked. We tested interactions between variables for additional analysis, with access to funding (SB) as a moderating variable. We also tested the robustness of the model using the dynamic panel generalized method of moments (GMM) to check the consistency of the results.

3. RESULT AND DISCUSSION

The descriptive statistics presented in Table 1 show that the average green investment for manufacturing firms was IDR 8.13 billion, with a relatively large standard deviation of IDR 4.73 billion. The maximum value reached IDR 357 billion, indicating a high level of corporate budget allocation for environmentally-oriented projects. This wide distribution aligns with the findings of Zheng and Jin (2023), who stated that green investment among firms is often asymmetrical, with most firms investing small amounts, while a small number of firms dominate with large-scale investments.

The average Corporate Governance Index (CGI) was recorded at 0.17 with a standard deviation of 0.29. The minimum value of –0.20 and the maximum value of 0.58 indicate heterogeneity in corporate governance quality within the sample. This figure aligns with the literature emphasizing that corporate governance in emerging markets tends to be diverse and often still in its infancy (Li et al., 2024). This variation is important because better governance has the potential to increase investor confidence and strengthen firms' commitment to environmentally friendly investments.

The Sustainable Bonds variable has a mean of 0.173 with a standard deviation of 1.445, a minimum value of 1, and a maximum of 27. These results indicate that most manufacturing firms in Indonesia have not yet widely accessed bond-based green financing instruments, with only a handful of prominent firms using this instrument. This is consistent with the findings of Ding et al. (2023) and Tao and Chao (2024), who emphasized that although green financing can accelerate sustainable investment, its adoption in developing countries is still limited due to limited market access and low green financial literacy.

Table 1. Descriptive statistics

Source: Data processed with STATA, 2025.

Variable	Obs	Mean	Std. Dev.	Min	Max
Green Investment	779	8.139e+09	4.73e+9	1.80e+6	3.570e+11
LnGI	779	11.886	10.54	2.34	26.6
CGI	779	.17	.294	–.2	.58
SB	779	.173	1.445	1	27
Labor Cost	779	1.034e+12	8.489e+12	1.323e+09	1.175e+14
LnLC	779	24.846	1.788	21	32.4
Size	779	1.396e+13	4.404e+13	4.847e+10	4.729e+14
LnSize	779	28.574	1.691	24.604	33.79
ROA	779	1.901	14.236	–174	94.4
InsOwn	779	64.578	25.472	0	99.96
Debt	779	55.593	70.084	0	1020.29
Liq	779	5.502	35.917	.02	577.69
GDP	779	3.372	2.815	–2.07	5.31

The Labor Cost variable showed an average value of IDR 1.03 trillion with a standard deviation of IDR 8.48 trillion. The minimum value was re-

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Table 2. Matrix of correlations

Source: Data processed with STATA, 2025.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) LnGI	1.000									
(2) CGI	0.237	1.000								
(3) Sustainable Bonds	0.129	0.052	1.000							
(4) LnLC	0.200	0.038	0.138	1.000						
(5) LnSize	0.250	0.041	0.236	0.086	1.000					
(6) ROA	0.081	0.009	0.014	0.132	0.150	1.000				
(7) InsOwn	−0.011	0.033	−0.029	0.044	0.075	−0.049	1.000			
(8) Debt	−0.088	0.014	−0.015	−0.064	−0.109	−0.347	0.045	1.000		
(9) Liq	0.065	0.015	−0.010	−0.117	−0.090	0.008	−0.104	−0.086	1.000	
(10) GDP	0.225	0.097	0.045	0.023	0.041	0.044	0.021	0.014	0.005	1.000

corded at IDR 1.32 billion, and the maximum at IDR 117.5 trillion, indicating significant differences in the scale of operations between firms. Logarithmic transformation of the Labor Cost (LnLC) variable resulted in an average of 24.84 with a standard deviation of 1.78, a minimum of 21.0, and a maximum of 32.4. These results indicate that differences in labor costs are more generally distributed in the logarithmic form, making them more suitable for econometric models. This finding aligns with the literature emphasizing that labor costs are often an important determinant of corporate investment decisions, including green investment (Mei & Zhang, 2025).

The correlation matrix analysis in Table 2 provides an initial overview of the relationships between variables in the research model. The correlation results indicate that the green investment variable has a moderate positive correlation with the corporate governance index (0.237), with sustainable bonds (0.129), with labor costs (0.200), and with company size (0.250). This indicates that firms with better governance, access to sustainable funding, higher labor costs, and larger company size tend to have higher green investment. These correlation results provide initial information that the relationships between the research variables tend to be low to moderate, so there is likely no indication of multicollinearity.

3.1. The impact of corporate governance on green investment

The results of the hypothesis test in Table 3 show that the Corporate Governance Index (CGI) positively and significantly affects green investment. In model (1), the CGI coefficient is 0.791 with a t-statistic of 2.39, while in model (2) the coefficient increases to 0.872 with a t-statistic of 2.01. Both results are significant at the 5% confidence level, meaning the hypothesis that corporate governance plays a significant role in encouraging increased green investment is supported by empirical data. Thus, the better the corporate governance practices, the higher the tendency of firms to allocate resources towards green investment. Good corporate governance increases legitimacy before the public and regulators, thus encouraging firms to allocate more resources to green investment as a form of compliance and reputation strategy. CGI is an institutional mechanism in determining internal corporate strategies to respond to external pressures on green investment (Bai et al., 2025; Donkor et al., 2025).

These findings are consistent with previous literature emphasizing the role of corporate governance in strengthening corporate environmental commitment. Good corporate governance can substitute for tunneling practices and encourage the allocation of funds to environmental investments (Q. Li et al., 2024). Furthermore, corporate governance also plays a role in improving the quality of environmental information disclosure, strengthening corporate legitimacy in the eyes of investors and stakeholders (J. Sun et al., 2025). This strengthens the argument that CGI is not only related to internal oversight but also serves as a strategic mechanism to encourage firms to invest in environmentally friendly projects.

Table 3. Results of independent variable hypothesis testing on green investment

Variable	Green investment	
	(1)	(2)
CGI	0.791** (2.39)	0.872** (2.01)
SB	0.108** (2.07)	0.0728* (1.83)
LnLC	0.726*** (5.00)	0.288** (2.13)
LnSize		0.725*** (3.81)
ROA		−0.00085 (−0.10)
InsOwn		−0.0247** (−2.91)
Debt		0.00453 (1.53)
Liq		0.00869 (1.49)
gdp		−0.0171 (−0.38)
_cons	−17.51*** (−4.86)	−25.98*** (−6.30)
Number of obs	779	779
R-squared	0.840	0.852
Chi-square	4134.095	4259.703
Prob > chi2	0.000	0.000
Hausman	0.147	0.168

Note: ***, **, and * denote statistically significant variables at 1%, 5% and 10% levels, respectively, with t-statistics in parentheses.

These results align with the study by Li et al. (2025), who found that board independence mediates financial governance and asset allocation, which has implications for a company's capacity to manage long-term investment risks, including green investment. Wang et al. (2025) added that a strong governance structure can mitigate a company's legal risk, creating institutional stability that supports the realization of sustainable investment. Even in the context of innovation, managerial power balanced with a long-term investment strategy improves a company's green innovation performance (G. Ding et al., 2025), thus supporting the logic that CGI encourages more visionary decision-making related to sustainability.

Strong governance can also increase green investors' confidence in providing financial support. Yu and Zhang (2025) documented that green investors strengthen a company's sustainability commitment when governance levels are high, as governance serves as a signal that invested funds are managed accountably. This finding is further supported by Yoshida et al. (2025), who found that climate risk and governance quality drive green merger and acquisition activity, suggesting that governance plays a role in shaping corporate investment strategies on a broader scale.

This study's empirical findings are consistent with previous evidence and extend the literature by demonstrating that the positive relationship between CGI and green investment remains robust even when tested in different models. The positive relationship between CGI and green investment also strengthens the argument that corporate governance is a strategic determinant influencing a company's ability to navigate external uncertainty. Climate change, the energy transition, and regulatory and market uncertainty are important factors influencing corporate investment decisions. Good governance can reduce internal uncertainty, increase accountability, and strengthen positive signals to the market, thus making firms more confident in making long-term green investment decisions (D. Li, 2025; Zhu & Chao, 2025).

3.2. The impact of the sustainability bond on green investment

The results of the hypothesis testing indicate that the Sustainability Bond (SB) variable has a positive influence on green investment. In model (1), the SB coefficient is 0.108 with a t-statistic of 2.07, significant at the 5% level. Meanwhile, in model (2), although the coefficient decreases to 0.0728, the SB variable remains significant at the 10% level with a t-statistic of 1.83. This finding confirms that sustainable financing instruments through green bonds play an important role in increasing the allocation of corporate funds for green investment. However, its strength is relatively weaker compared to corporate governance variables, so the hypothesis stating that Sustainability Bonds have a positive influence on green investment is statistically proven.

Access to green financing provides firms with a reliable source of financial resources to finance environmentally friendly projects. This is consistent with research emphasizing that the green bond market functions as a de-risking mechanism, reducing the financial risks typically inherent in green investments (Braga et al., 2021).

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Through this instrument, investors gain assurance that their funds are being used for sustainable purposes, while firms can obtain capital at a lower cost, thus encouraging green investments. Furthermore, green investors also have goal-oriented preferences, where green bonds are viewed not only as a financial instrument but also as a means to realize sustainable investment strategies (Chen et al., 2025). Therefore, issuing sustainability bonds serves as an important signal to firms that the capital market is willing to provide financial support for green initiatives.

The results of this study also align with the literature linking green bonds to sustainable economic growth. Green bonds catalyze ESG investments with green economic growth, particularly in resource-rich countries (L. Huang, 2024). In Indonesia, which is also rich in natural resources, sustainability bonds can serve as a bridge between industrial development needs and the sustainability agenda, thus driving structural transformation towards a low-carbon economy. S. Huang et al. (2025) add an interesting dimension by developing a sentiment analysis-based green bond index. They show that green bond market dynamics can be influenced by investor perceptions and expectations, which ultimately impact the price and liquidity of these instruments. This is relevant to explain why the SB coefficient in this research model decreases in the second estimation, as fluctuations in market sentiment or uncertainty regarding the use of funds can moderate the impact of sustainability bonds on green investment.

Furthermore, the role of green bonds must also be understood within the integration framework between public policy and the financial sector. Zhao et al. (2022) assert that green bonds contribute to green economic recovery by supporting energy efficiency and sustainable infrastructure projects. Meanwhile, other research highlights that European Union policies related to green bonds and carbon taxes produce multi-layered effects on investment, encompassing economic, social, and environmental impacts (Smeets Křístková et al., 2025). From this perspective, sustainability bonds in Indonesia can be viewed as an instrument with the potential to provide dual benefits: strengthening green investment while supporting a more inclusive and sustainable national development agenda.

3.3. The impact of labor cost on green investment

Based on the regression results in Table 3, the LnLC (Labor Cost) variable shows a relatively large and significant coefficient value on green investment. In model (1), the LnLC coefficient is 0.726, significant at the 1% level, while in model (2), the coefficient is 0.288, significant at the 5% level. These results indicate that increasing labor costs has a positive and significant effect on green investment, although the strength of the effect decreases in the second model. Thus, the hypothesis that labor costs affect green investment can be accepted. Econometrically, these results indicate that firms facing increasing labor costs are encouraged to invest more in environmentally friendly projects through energy efficiency, automation, or green innovations that can reduce long-term costs.

These findings align with literature emphasizing the complex relationship between labor costs, environmental policies, and green investment strategies. Wei et al. (2023) show that green tax reforms in China affect the distribution of labor income, with environmental burdens often transferred to workers through a lower wage share. Increasing labor costs can encourage firms to seek more efficiency-oriented investment alternatives, one of which is green investment. Green investment allows firms to reduce their reliance on labor-intensive inputs and replace them with more efficient green technologies. Furthermore, Wei et al. (2024) found that green factory policies reduced labor income, reflecting the substitution between labor and environmentally friendly technologies. This is consistent with the positive LnLC coefficient in this study. When labor costs increase, firms tend to substitute through investment in green innovations that can reduce the use of traditional labor, increase productivity, and meet environmental standards.

Recent literature also links labor cost dynamics to the skill structure of the workforce and the adoption of advanced technologies. Applying artificial intelligence in the green total factor productivity context requires a match between labor skills and machines (Yang & Kuang, 2025). This strengthens the argument that rising labor costs encourage firms to invest in digital-based green technologies,

not only for cost efficiency but also to improve overall green productivity. In other words, green investment can be viewed as a strategic response to high labor cost pressures. Besides that, Jiang and Jiang's (2023) study shows that green finance policies influence labor demand by incentivizing firms to shift to sustainable production models. This finding is relevant to research showing a positive effect of labor costs on green investment. When labor costs increase, incentives from green policies strengthen firms' motivation to invest in more labor-efficient green technologies. Furthermore, the research findings can be explained through the labor-saving heuristics approach described by Rughi et al. (2025), who found that green patents are often labor-saving, reducing the need for traditional labor. Within this framework, increasing labor costs encourage firms to adopt labor-saving green innovations, strengthening the argument that green investment is a rational strategy in the face of labor cost pressures.

The results of this study indicate a dynamic interaction between labor costs, green investment, and labor productivity. Rising labor costs are seen as a burden and a catalyst for firms to accelerate the adoption of green investment (Gong et al., 2020). This aligns with the literature's perspective that transforming a green economy requires an integrative strategy, in which labor factors, environmental policies, and technological innovation are interconnected (X. Yu et al., 2024). In other words, green investment can be viewed as an adaptive mechanism that bridges the tension between rising labor costs and the demands of long-term sustainability.

3.4. Further analysis

This study further examines the role of capital expenditure (CapEx) in moderating the influence of corporate governance, sustainability bonds, and labor costs on green investment. Table 4 shows that capital expenditure strengthens the influence of Corporate Governance on green investment. This supports the literature emphasizing that green investment disclosure will only be adequate if supported by a concrete commitment to financial resource allocation and capital expenditure. He et al. (2024) emphasize the importance of consistency between green bond issuance and green investment realization. Therefore, disclosure alone is insufficient; capital allocation is needed to enhance sustainability credibility. Chen et al. (2025) also emphasized that investors respond positively to goal-oriented strategies only when concrete implementation mechanisms exist. Capex provides concrete evidence that corporate disclosures are not merely greenwashing (Shi et al., 2023) but result in realizing measurable green projects. Thus, the combination of CGI and Capex creates greater credibility in the eyes of both investors and regulators, strengthening the push for green investment.

Table 4. Results of the moderation test of independent variables in green investment

Variable	Green investment		
	(1)	(2)	(3)
CGI	4.086*** (4.18)	4.572*** (4.71)	4.526*** (4.66)
Capex	−6.12E−14 (−0.85)	−9.22E−15 (−0.13)	−1.97E−12 (−1.31)
CGCPX	8.14e−13*** (2.91)		
SB	−0.0257 (−0.10)	0.583** (2.26)	0.28** (2.20)
LnLC	0.533** (2.16)	0.575** (2.26)	0.564** (2.23)
LnSize	1.162*** (2.6)	1.144** (2.55)	1.217*** (2.71)
ROA	−0.0202 (−1.00)	−0.0206 (−1.02)	−0.0209 (−1.03)
InsOwn	−0.0132 (−0.65)	−0.0133 (−0.66)	−0.0147 (−0.73)
Debt	0.0015 (0.22)	0.00121 (0.17)	0.00114 (0.16)
Liq	0.0198 (1.44)	0.0196 (1.42)	0.0195 (1.41)
GDP	0.452*** (4.51)	0.445*** (4.41)	0.444*** (4.4)
SBCPX		−2.41E−14 (−1.49)	
LCCPX			6.47E−14 (1.29)
_cons	−36.25*** (−3.61)	−36.84*** (−3.67)	−38.42*** (−3.82)
Number of obs	779	779	779
R−squared	0.1234	0.1266	0.1260
Chi−square	10.66	9.76	10.32
Prob > chi2	0.000	0.000	0.000
Hausman	0.2999	0.3704	0.3255

Note: ***, **, and * denote statistically significant variables at 1%, 5% and 10% levels, respectively, with t-statistics in parentheses.

In contrast to the CGI, the results of the SBCPX indicate that capital expenditure (CapEx) does not strengthen, and in fact tends to weaken, the

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relationship between sustainability bonds and green investment. This is interesting because sustainability bonds theoretically function as financial instruments to support green projects (Braga et al., 2021; L. Huang, 2024). However, empirical results indicate a misalignment between sustainable bond issuance and capital expenditure allocation for green investment. This can occur because firms may use sustainable bond funds for non-green purposes (misallocation), there is a risk of greenwashing (Shi et al., 2023), and there is financial crowding-out, as discussed (Smeets Křístková et al., 2025), where financing through bonds can replace the company's internal allocation (CapEx) rather than complement it. As a result, sustainability bonds do not always lead to increased green investment, especially if the Capex is not directed towards relevant green projects.

The results on LCCPX show a positive, though insignificant, relationship, indicating that capital expenditure can strengthen a company's tendency to respond to rising labor costs through green investment. This finding is consistent with the theory of labor substitution with green technology (Wei et al., 2024). The implementation of green factories often reduces the share of labor income, indicating a substitution between labor and technology. Capex allows firms to invest in labor-saving green technologies (Rughi et al., 2025), such as clean energy-based automation or energy efficiency in production processes. Thus, although the moderating effect is not statistically significant, this result points in a direction consistent with the literature, where Capex provides firms with the capacity to transform labor cost pressures into efficiency opportunities through green investment.

The results show that Capex is a significant moderator in the relationship between CGI and green investment, but is insignificant in the relationship between SB and LC. The positive influence of CGI on green investment becomes stronger when supported by adequate capital expenditure allocation. Conversely, sustainability bonds do not always increase green investment when CapEx is involved, indicating potential greenwashing or misallocation of funds. Meanwhile, Capex tends to strengthen the relationship between labor costs and green investment through technology substitution, although the effect is not yet significant. These results confirm that internal capital expenditure allocation is crucial in determining whether a company's sustainability commitment is truly realized in the form of tangible green investment.

CONCLUSION

This study aims to obtain empirical evidence on the impact of corporate governance (CGI), sustainable financing through sustainability bonds, labor costs on green investment, and the moderating role of capital expenditure. The estimation results indicate that good corporate governance has a positive and significant effect on green investment. This finding strengthens the argument that transparent and accountable governance mechanisms encourage companies to allocate resources to environmentally friendly projects, in line with legitimacy theory, which emphasizes the importance of sustainability in gaining stakeholder support. Sustainability bonds are proven to contribute positively to increasing green investment, although their strength varies depending on the support of internal company factors. Labor costs have a significant effect on green investment, indicating that cost pressures encourage companies to shift to efficiency strategies through the adoption of green technologies. Capex is proven to be an important moderator, particularly in strengthening the effect of corporate governance on green investment. However, its role in relation to sustainability bonds and labor costs is relatively weaker.

These findings suggest that the success of a sustainability strategy is determined not only by transparency and access to green financing but also by a company's ability to integrate these commitments into its capital investment policy. Therefore, effective green investment requires synergy between corporate governance, financing, and internal resource management strategies. These findings broaden the perspective of previous literature that emphasizes the role of disclosure and green financing instruments, demonstrating that without the support of capital investment, these commitments can potentially fall

into the trap of greenwashing. Furthermore, the findings on labor costs broaden the theoretical discourse on the relationship between production factors and green transformation, where cost pressures can drive environmentally friendly technological innovation.

This study offers several strategic implications. For firms, the results underscore the importance of aligning governance disclosures and green financing instruments with capital expenditure strategies to maintain sustainability credibility and generate tangible impacts on green investment. Investors should also consider the synergy between disclosures, financing sources, and capital expenditure when evaluating the quality of a company's green commitments. For policymakers, the results emphasize the need for fiscal incentives or regulations to encourage firms to direct capital expenditures toward environmentally friendly projects and oversight mechanisms for using sustainable bonds to minimize the risk of misallocation or greenwashing.

AUTHOR CONTRIBUTIONS

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