DOES INNOVATION STRENGTHEN THE IMPACT OF SUSTAINABILITY ON FIRM VALUE?

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Abstract

This study explores the effect of sustainability on firm value, with innovation as a moderating variable. Despite various sustainability initiatives, the inconsistent impact of sustainability practices on firm value raises questions about what factors truly enhance the effectiveness of these practices in delivering business value. Prior studies suggest a mixed relationship between sustainability and firm value (Agustia et al., 2019; Ammer et al., 2020). Using data from companies listed on the Indonesia Stock Exchange (IDX) from 2018 to 2022, sustainability is measured by the Global Reporting Initiative (GRI) index, firm value by return on assets (ROA), and innovation by research and development (R&D) expenditures. Panel data regression analysis was conducted using the STATA application. The results show that sustainability alone does not significantly influence firm value. When interacting with innovation, the relationship becomes significantly positive, indicating that innovation strengthens the impact of sustainability on firm value. These findings emphasize the importance of embedding innovation within sustainability strategies. Practically, it highlights the need for companies and policymakers to invest in R&D as part of broader sustainability initiatives. The originality of this research lies in its focus on a developing country context, offering practical and academic insights into the integration of innovation and sustainability.

Keywords: Corporate Innovation, R&D, Sustainability, GRI Index, Firm Value, Indonesia Stock Exchange

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1. INTRODUCTION

Sustainability has become a significant concern in Indonesia, aligning with the increasing global recognition of the value of sustainable development (Jati et al., 2023). However, compared to other countries worldwide, Indonesia's sustainability performance remains relatively low. The country's performance in sustainability lags behind that of nations such as Malaysia and several European countries (Papilo et al., 2018). One of the main contributing factors to this underperformance is the limited implementation of effective policies and the lack of incentives for companies to invest in sustainable practices (Firmialy & Nainggolan, 2019). The Indonesian government has implemented various regulations to enhance sustainability performance, such as PROPER (Company Performance Rating Programme), issued by the Ministry of Environment and Forestry; however, numerous companies continue to fall short of the defined standards (Susilawati & Kanowski, 2020). PROPER is a program initiated by the Ministry of Environment and Forestry in Indonesia to motivate companies to exhibit environmental accountability and regulatory adherence. Despite the government's commitment to enhancing sustainability performance, numerous firms continue to overlook these aspects, as they are

often perceived as not yielding immediate financial benefits (Tjahjadi et al., 2021). According to Salim et al. (2018), the weak sustainability performance is linked to the belief that adopting sustainability initiatives does not contribute added value to the company.

In contrast, Ismail et al. (2022) highlighted that sustainability has a positive impact on firm value, as it enhances trust and loyalty among consumers and investors. Pusparini et al. (2020) argue that the implementation of environmentally friendly strategies can enhance business performance through operational efficiency and stakeholder satisfaction. Strong environmental disclosure is often associated with effective corporate governance, which ensures regulatory compliance and boosts investor confidence (Itan et al., 2023). Good corporate governance and sustainability directly contribute to a more transparent and accountable company performance (Yopie & Robin, 2023). However, several studies have offered differing perspectives on this issue (Ammer et al., 2020; Astari et al., 2023; Nguyen, 2020). Nguyen (2020) discovered that sustainability reporting can negatively affect firm value, as the expenses involved in reporting frequently surpass the short-term advantages obtained. Similarly, Ammer et al. (2020) argue that sustainability does not significantly influence firm value in Indonesia unless accompanied by effective management. This uncertainty suggests that additional factors influencing the relationship have yet to be fully explored. To address this gap, introducing innovation as a moderating variable enables further examination of whether more innovative firms derive greater benefits from sustainability efforts, thereby clarifying the nature of this relationship.

Indonesia has shown progress in the area of innovation, as reflected in the 2023 Global Innovation Index (GII) report published by the World Intellectual Property Organization (WIPO). In 2022, Indonesia ranked 75th globally and improved its position to 54th in 2024. While this marks a significant improvement, Indonesia still lags behind its Southeast Asian neighbours. Singapore, for instance, ranked 4th globally, while Malaysia was placed 33rd (WIPO, 2024). Several companies in Indonesia have begun to implement various innovations to support their sustainability performance, including improved waste management and the use of renewable energy sources (Khair & Rini, 2023), as well as innovations in sustainable supply chain management (Novitasari & Agustia, 2021). Therefore, innovation is vital in enhancing a company's sustainability performance, as it enables greater efficiency and competitiveness (Agustina & Retha, 2023). In this context, innovation becomes essential for Indonesian firms seeking to improve their competitiveness in both domestic and international markets. Furthermore, innovation can strengthen sustainability performance by enabling the development of more efficient and sustainable products and services, while encouraging firms to minimise their environmental impact (Timotius, 2023). As such, innovation can serve as a moderating factor, since companies that embrace innovation tend to be more adaptive and responsive to changing market demands and regulatory requirements, ultimately leading to increased firm value (Kunene & Chung, 2020). Sustainability is often perceived as not providing immediate financial benefits; however, through innovation, companies can integrate operational efficiencies and new environmentally friendly processes, enhance competitiveness, and mitigate environmental risks (Agustina & Retha, 2023). However, there remains some debate among scholars regarding whether innovation indeed strengthens sustainability practices and contributes to firm value (Adi Tristanto et al., 2023); thus, further investigation is needed.

Despite increasing academic attention, existing studies present mixed findings on the impact of sustainability on firm value, highlighting a literature gap regarding contextual and moderating variables. This study aims to explore how innovation can serve as a moderating factor that strengthens the relationship between sustainability and firm value, given its role in generating added value from sustainable practices. As such, the research question developed in this study is:

RQ: How can firm's innovation influence the effectiveness of sustainability practice in improving firm value?

The significance of this study lies in its investigation of an emerging market context through panel data regression analysis, offering new empirical insights to the existing literature on sustainability and firm value. In addition, the study provides a practical contribution for businesses by offering insights into how adopting innovation-driven strategies can enhance sustainability practices, ultimately leading to increased firm value.

The rest of this paper is structured as follows. Section 2 presents the literature review and hypotheses development. Section 3 discusses the research methodology. Section 4 reports the empirical results. Section 5 provides the discussion. Section 6 concludes the paper with implications, limitations, and suggestions for future research.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1. Theoretical framework

Signalling theory explains how companies utilise sustainability practices as positive signals to investors and external stakeholders. For instance, Kim and Kim (2018) found that firms that report on their sustainability practices and are subject to external oversight signal stronger governance and disclosure practices. This, in turn, enhances firm value by increasing market trust and improving market responses to earnings announcements. Furthermore, innovation also acts as a signal that a company is not solely focused on short-term profits but possesses a long-term vision for innovation and environmental risk mitigation. This is supported by Agustia et al. (2019), who demonstrated that innovation strengthens a company's competitiveness and enhances its firm value. A study by Saleh (2020) shows that firms that effectively manage sustainability strengthen relationships with stakeholders and gain investor trust, ultimately enhancing firm value. Furthermore, innovation implemented by companies can help mitigate negative environmental impacts and reinforce their commitment to sustainability, which is crucial for external stakeholders. Chen and Liu (2019), Dai and Xue (2022) found that innovations,

such as environmentally friendly product innovation, improve operational efficiency, enhance competitiveness, and have a positive impact on firm value, aligning with the interests of all stakeholders. Companies that consider the interests of all stakeholders through sustainability practices demonstrate that they are not solely focused on financial gains, but also take into account their social and environmental impact.

In addition to signalling theory, this study also used stakeholder theory, which offers a compelling framework to explain the importance of sustainability. This theory asserts that firms have obligations not only to shareholders but also to a broader range of stakeholders, including customers, employees, communities, and the environment. In this context, sustainability and innovation strategies serve not only to enhance firm value but also to respond to rising stakeholder expectations regarding ethical and sustainable business practices (Freeman et al., 2020).

2.2. Sustainability and firm value

Several studies have shown that sustainability has a positive impact on firm value. Zhou et al. (2022) found that companies implementing sustainable practices tend to achieve better market performance and higher firm value. Saleh (2020) further argues that sustainability initiatives can create long-term value for shareholders by effectively managing social, environmental, and economic risks. This is supported by Shad et al. (2019), who observed that firms engaging in sustainable practices generally perform better in the market and possess higher firm value, as investors view sustainability as an indicator of sound risk management. Glembotskaya et al. (2020) emphasised that sustainability reporting, when accompanied by external oversight, enhances stakeholder trust and ultimately boosts firm value. Additionally, Agustia et al. (2019) found that innovation and sound environmental management practices improve a firm's competitiveness, reinforce investor confidence, and reduce environmental risks, all of which positively influence firm value. Similarly, Donkor et al. (2025) highlighted that companies with worsening emission performance negatively affect firm value, which confirms stakeholder and legitimacy theories, indicating that stakeholders respond to firms' sustainability practices, thereby pressuring them to act more responsibly towards the environment. Furthermore, Miralles-Quirós et al. (2018) highlighted that socially and ethically responsible business practices within a sustainability framework enhance market trust and positively impact firm value in the stock market.

However, some studies argue that sustainability does not always have a positive impact. According to Ammer et al. (2020), sustainability reporting does not significantly influence firm value unless supported by strong corporate governance. Nguyen (2020) found that elevated levels of sustainability reporting, especially when aligned with the Global Reporting Initiative (GRI) guidelines, could potentially have a negative impact on firm value, as the expenses linked to such reporting often exceed the perceived advantages. A study by Rahi et al. (2022) confirmed the adverse relationship between sustainability practices and firm performance, which may result from the long-term investment demands that negatively influence firm outcomes. In the Indonesian context, sustainability reporting has not demonstrated a notably positive impact on firm value, particularly because improvements in the quality of sustainability reports have not been accompanied by corresponding increases in firm value, a situation further exacerbated by unstable economic conditions during the study period (Astari et al., 2023).

Considering the mixed results in prior research on the impact of sustainability on firm value, additional exploration is required. Although certain studies have found a positive effect of sustainability on firm value (Agustia et al., 2019; Glembotskaya et al., 2020; Saleh, 2020), others have found no significant effect (Ammer et al., 2020; Astari et al., 2023; Nguyen, 2020). Nevertheless, sustainability may exert a positive influence on firm value in Indonesia through effective sustainability reporting, as such reporting can enhance transparency, reduce information asymmetry, and send positive signals to the market, ultimately strengthening investor confidence in the firm (Sahetapy, 2023). As such, the hypotheses in this study are developed as follows:

H1: Sustainability has a positive effect on firm value.

2.3. Firm innovation

Some studies support the view that innovation can strengthen the influence of sustainability on firm value. Cooper et al. (2022) found that innovation enhances resource-use efficiency, ultimately reinforcing firm value. Another study by Shin et al. (2018) showed that innovation not only improves efficiency but also increases investment appeal, as firms that adopt innovation demonstrate a commitment to long-term sustainability that is recognised by the market. Lopes et al. (2022) concluded that sustainability-oriented innovation can provide a significant competitive advantage, enhancing both firm performance and market value. Meanwhile, Dai and Xue (2022) noted that growth-stage companies adopting innovation gain long-term benefits, as such innovation helps reduce environmental costs and improve competitiveness. Chen and Liu (2019) also supported the view that innovations, such as environmentally friendly products and process innovations, positively impact firm value, especially in highly competitive markets. Dai and Xue (2022) further noted that companies adopting innovation gain long-term benefits in terms of firm value, as innovation helps reduce environmental costs and boosts competitiveness. However, Ge et al. (2018) contended that innovation does not necessarily enhance the connection between sustainability and firm value, especially when it is executed without a well-defined strategy, which in some instances may even reduce the advantages of sustainability. Therefore, the role of innovation in the sustainability-firm value relationship remains ambiguous. To address this gap, the present study seeks to investigate how innovation contributes to reinforcing the relationship between sustainability and firm value by proposing the following hypothesis:

H2: Innovation as a moderating variable enhances the relationship between sustainability and firm value.

3. RESEARCH METHODOLOGY

3.1. Data collection and analysis

This research utilizes secondary data sourced from companies listed on the Indonesia Stock Exchange (IDX) for the period 2018 to 2022. This timeframe was chosen due to significant advancements in sustainability and innovation-related policies and regulations in Indonesia in recent years. The data utilised includes annual reports and financial statements, encompassing information on sustainability practices, innovation activities, and financial performance. The sample selection was carried out using a purposive sampling method, based on the criteria such as: 1) companies that issued annual reports and sustainability reports in five years from 2018 to 2022; 2) companies must have complete data on the variables to be tested, including the dependent, independent, moderating, and control variables. In total, the study observed 815 data points, drawn from 163 Indonesian companies. The data was analysed using the STATA software with a panel data regression approach. The tests and analyses conducted included descriptive statistics, Pearson correlation analysis, hypothesis testing, and robustness testing. In addition, since sustainability regulations in Indonesia remain largely voluntary and are not uniformly enforced across sectors, many firms are not legally required to produce or disclose sustainability reports consistently, resulting in minimal sectoral variation. Thus, this study only controls for such differences through the application of industry fixed effects to mitigate potential bias (Kemp et al., 2021).

Although this study employs panel data regression, alternative methods such as generalized method of moments (GMM) or instrumental variables (IV) regression could be used in future research to address endogeneity concerns. These approaches are particularly useful in overcoming potential biases arising from omitted variable issues or reverse causality, which are common in observational data settings.

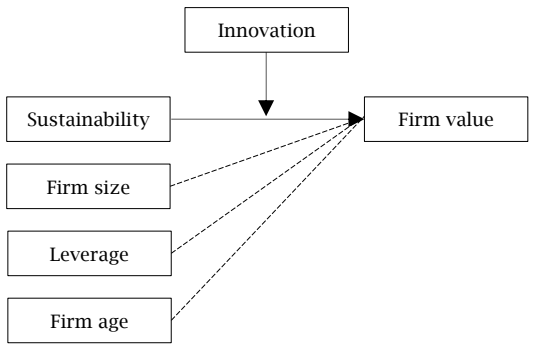
3.2. Variables and model

This research measures firm value as the dependent variable using return on assets (ROA), which indicates the firm's effectiveness in generating earnings from its overall assets. ROA is commonly used as an indicator of financial performance, particularly in relation to sustainability policies (Kılıç et al., 2022). The independent variable sustainability is assessed using scores derived from the GRI standards. This study employs the GRI index as the sustainability measure due to the limited availability of alternative sustainability practice data in the Indonesian context. Sustainability practices have not been uniformly adopted, nor mandated across all firms, making GRI a practical and standardized framework for assessing sustainability disclosure. Although not a locally developed metric, GRI is the most widely adopted reporting standard among Indonesian companies, enabling comparability and consistency in sustainability reporting (Putri et al., 2020; Saeed & Zamir, 2021). These standards act as an international reference point for evaluating corporate sustainability performance across three key dimensions: economic, environmental, and social. The GRI score offers a systematic framework for assessing a firm's dedication to sustainable practices (Putri et al., 2020). Meanwhile, innovation as the moderating variable is measured using research and development (R&D) expenditure data, which represents a firm's investment in creating new technologies and innovative products. The use of R&D expenditure as the proxy for innovation in this study is driven by data availability constraints from publicly listed companies in Indonesia. Most firms do not consistently disclose innovation output, such as patents or new product introductions, in their annual reports. Patents in Indonesia are also considered very limited. Therefore, R&D remains the most accessible and systematically reported measure via financial statements of IDX-listed companies. This approach aligns with prior studies in emerging economies that face similar challenges in capturing innovation comprehensively (Ravšelj & Aristovnik, 2020; Xu et al., 2022). This investment is expected to support sustainability initiatives and enhance overall firm performance (Ravšelj & Aristovnik, 2020).

This study also considers several control variables to minimise potential bias. These include firm size, measured by the logarithm of total assets, which reflects the scale of the company in relation to sustainability and innovation (Maryana & Carolina, 2021). Additionally, firm age is measured based on the number of years since the company's establishment up to the research period, representing the firm's experience and stability (Sembiring Kembaren & Endro, 2022). Lastly, leverage is measured by the ratio of total debt to total equity, indicating the extent to which the company relies on debt in its operations and how this may affect financial performance and its ability to invest in innovation (Chang et al., 2021).

The following framework was developed in this study.

Figure 1. Research's framework



Source: Authors' elaboration.

For the regression model, this study estimated the relationship in two regression models to confirm the hypothesis. The regression models are as follows:

$$ROA_{it} = \alpha_i + \beta_1 SNB_{it} + \beta_2 FZ_{it} + \beta_3 LEV_{it} + \beta_4 FA_{it} + \varepsilon_{it} \quad (1)$$

$$ROA_{it} = \alpha_i + \beta_1 SNB_{it} + \beta_2 RND_{it} + \beta_3 SNB * RND_{it} + \beta_4 FZ_{it} + \beta_5 LEV_{it} + \beta_6 FA_{it} + \varepsilon_{it} \quad (2)$$

where:

- ROA_{it} is firm value of firm *i* in period *t*;
- α_i is the constant term;
- SNB_{it} is sustainability of firm *i* in period *t*;
- RND_{it} is innovation of firm *i* in period *t*;
- FZ_{it} is firm size of firm *i* in period *t*;
- LEV_{it} is leverage of firm *i* in period *t*;
- FA_{it} is firm age of firm *i* in period *t*;
- ε_{it} is the error term.

4. DATA ANALYSIS AND RESULTS

4.1. Descriptive statistics

The results of the descriptive statistical analysis provide a useful preliminary overview of the data examined in this study, particularly in the context of the relationship between sustainability (*SNB*), innovation (*RND*), and firm value (*ROA*) in Indonesia.

Table 1. Descriptive statistics of quantitative data

Variables	*Mean*	*Median*	*Minimum*	*Maximum*
ROA	0.067	0.038	0.000	0.585
SNB	3.047	2.270	0.000	38.333
RND	0.002	0.000	0.000	0.058
FZ	27.014	30.034	0.000	34.812
LEV	0.506	0.513	0.000	1.849
FA	35.036	32.000	0.000	108.000

Table 1 shows that *ROA* has a mean value of 0.067, with a median of 0.038, indicating that the majority of firms in the sample exhibit relatively low efficiency in generating profits from their total assets. The *ROA* values range from 0 to 0.585, reflecting substantial variation between highly efficient firms and those that are less effective in managing their assets. This variation aligns with findings from previous studies, which suggest that while sustainability can have a positive impact on firm value, the extent of that impact varies depending on several factors (Agustia et al., 2019). Meanwhile, *SNB* shows a mean of 3.047 and a median of 2.270, with values ranging from 0 to 38.333, indicating significant variation in the level of corporate commitment to sustainability. While many firms are engaging in sustainability efforts, the wide range suggests that some companies are considerably more progressive in implementing sustainable practices, whereas others may only be meeting the minimum regulatory requirements. This supports the view that, despite the Indonesian government's efforts in establishing various sustainability-related regulations, a large proportion of companies have yet to fully commit to more advanced sustainability practices, largely due to the perceived immediate costs associated with such initiatives (Tjahjadi et al., 2021).

RND, used as a measure of innovation, is recorded at a very low level, with a mean of 0.002 and a median of 0.000, ranging from 0 to 0.058, indicating that the majority of companies in the sample invest minimally in innovation. This limited investment may be attributed to a lack of incentives and government policy support, as well as challenges in transitioning to more sustainable business models (Sulistyawati & Ratmono, 2023). The low levels of *RND* investment are also consistent with Indonesia's relatively weak performance in innovation compared to its Southeast Asian counterparts. Nonetheless, there are some firms that have begun to show progress in this area, suggesting a growing awareness of the importance of innovation for long-term competitiveness and sustainability (Papilo et al., 2018).

For control variables, firm size (*FZ*) has a mean of 27.014, a median of 30.034, and ranges from 0 to 34.812. This indicates substantial variation in company size within the sample, which may influence their capacity to invest in sustainability and innovation initiatives. As noted in stakeholder theory, larger firms are generally more capable of adopting advanced sustainability practices due to their greater access to financial and organisational resources. These firms are also more visible to stakeholders, which increases pressure to demonstrate social and environmental responsibility, thus making firm size a potentially influential factor in the relationship between sustainability, innovation, and firm value (Saleh, 2020). Leverage (*LEV*) has a mean of 0.506 and a median of 0.513, with values ranging from 0 to 1.849. These values suggest that most companies in the sample maintain a relatively moderate level of debt. Such leverage levels may influence a firm's capacity to invest in sustainability and innovation. High leverage can constrain financial flexibility, limiting a company's ability to undertake necessary investments in areas that enhance sustainability performance and foster innovation. Conversely, firms with lower debt levels may have greater room to allocate resources toward long-term value-creating initiatives (Chang et al., 2021). Firm age (*FA*) shows a mean of 35.036 years and a median of 32 years, with values ranging from 0 to 108 years. This indicates that the majority of firms in the sample have been operating for a considerable period, suggesting a high level of experience. Such longevity may offer advantages in terms of business stability and the ability to develop more integrated strategies, particularly in relation to sustainability and innovation (Sembiring Kembaren & Endro, 2022). Older firms may also possess more established systems and stakeholder relationships, enabling them to better implement and benefit from long-term sustainability and innovation initiatives (Sembiring Kembaren & Endro, 2022).

4.2. Pearson correlation

The Pearson correlation test results illustrate the relationships among the primary variables analysed in this research. As shown in Table 2, *SNB* demonstrates a weak yet statistically significant positive correlation with *ROA*, marked by a correlation coefficient of 0.066 and a significance level of $p < 0.1$. This suggests that the implementation of corporate sustainability, although limited, does have a contributory impact on firm value. Additionally, the correlation between *RND* and *ROA* is also statistically significant, with a coefficient of 0.075 ($p < 0.05$). This indicates that investment in R&D can improve a company's efficiency and competitiveness, thereby positively affecting firm value. These outcomes align with the theoretical framework, suggesting that both sustainability and innovation can serve as drivers for enhancing firm value.

Table 2. Pearson correlation test result

Variables	*ROA*	*SNB*	*RND*	*FZ*	*LEV*	*FA*
ROA	1.000					
SNB	0.066*	1.000				
	(0.061)					
RND	0.075**	-0.045	1.000			
	(0.032)	(0.200)				
FZ	0.023	0.107***	0.028	1.000		
	(0.520)	(0.002)	(0.417)			
LEV	0.037	0.063*	-0.054	0.558***	1.000	
	(0.287)	(0.072)	(0.124)	(0.000)		
FA	0.103***	0.102***	0.111***	0.521***	0.428***	1.000
	(0.003)	(0.004)	(0.001)	(0.000)	(0.000)	

*Note: p-values in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

Moreover, *FZ* exhibits a significant positive correlation with *SNB*, with a correlation coefficient of 0.107 ($p < 0.01$), indicating that larger firms are generally more proactive in adopting sustainability initiatives, likely due to their broader resource availability. On the other hand, *LEV* shows a weak positive correlation with *SNB*, with a coefficient of 0.063 ($p < 0.1$). Additionally, *FA* demonstrates significant positive correlations with nearly all main variables, *ROA*, *SNB*, and *RND*, at the $p < 0.01$ level. These findings underscore the critical role of firm age in contributing to operational stability and enhancing participation in innovation and sustainability efforts. Overall, the observed correlations imply that firm-specific characteristics such as size, leverage, and age significantly influence a company's strategic focus on sustainability and innovation, which in turn affects its firm value.

4.3. Main regression results

The regression analysis aims to test the two hypotheses developed in this study, focusing on the individual and combined effects of sustainability and innovation on firm value. Model 1 evaluates the direct impact of sustainability on firm value, while Model 2 includes the interaction term between sustainability and innovation to test the moderating role of innovation. The analysis controls for firm size, leverage, and firm age, and applies both industry and year fixed effects. The results are summarized in Table 3 below.

Table 3. Regression results of sustainability on firm value with innovation as a moderating variable

Variables	*(1) ROA*	*(2) ROA*
SNB	0.001	0.001
	(0.96)	(0.88)
FZ	-0.001*	-0.001*
	(-1.80)	(-1.86)
LEV	0.023	0.025
	(0.95)	(1.00)
FA	0.001**	0.001**
	(2.47)	(2.39)
RND		-1.451**
		(-2.17)
SNB × RND		0.782***
		(3.31)
_cons	0.065***	0.064***
	(4.48)	(4.10)
Industry fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
r2	0.080	0.088
r2_a	0.061	0.067
N	815	815

*Note: t-statistics in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

The regression analysis in this study presents the relationship between *SNB*, *RND*, and *ROA*. The *SNB* variable shows a positive coefficient of 0.001, but it is not statistically significant across all model specifications, with t-statistics ranging from 0.88 to 1.01. This suggests that sustainability, as operationalized in this study, does not have a direct and significant effect on firm value, leading to the rejection of *H1*. Additionally, the results indicate that *FZ* has a significant negative association with *ROA*, implying that larger firms may be less efficient in utilizing their assets to generate profits. *LEV*, with a positive coefficient ranging from 0.023 to 0.025, is also statistically insignificant, indicating that leverage does not directly influence firm value. In contrast, *FA* demonstrates a positive and statistically significant relationship with *ROA* at the 5% significance level, with a coefficient of 0.001. This finding implies that older firms are generally more effective in generating returns from their assets.

Furthermore, *RND* displays a negative and statistically significant coefficient at the 5% level in Model 2, with a value of -1.451. This implies that, in the short term, innovation expenditure may place a financial burden on firm value. However, the interaction term between *SNB* and *RND* reveals a highly significant positive effect at the 1% level, with a coefficient of 0.782. This result demonstrates that innovation serves as a moderating factor that amplifies the positive impact of sustainability on firm value. When sustainability efforts are combined with innovation, firms are able to significantly enhance their value. Therefore, *H2* is accepted. The R-squared value rises from 0.080 in Model 1 to 0.088 in Model 2, indicating that the inclusion of the moderating variable contributes to a better explanation of the variation in firm value. These findings suggest that sustainability alone is not sufficient to drive firm value. Innovation plays a critical role in strengthening the link between sustainability and firm value.

4.4. Robustness analysis using coarsened exact matching

To strengthen the robustness of the research model and mitigate potential endogeneity concerns, the study employs coarsened exact matching (CEM), as illustrated in Tables 4 and 5. Endogeneity is a common and critical issue in empirical research, as it can distort the accuracy of findings (Hill et al., 2021). CEM is used to address the endogeneity issues and ensure the results are consistent, thus proving the consistency of the model in this study (Harymawan et al., 2023). The CEM test is conducted

by dividing the control variables into two strata based on the characteristics of the independent variables. CEM improves causal inference by creating balanced groups based on covariates, thereby reducing selection bias (Hill et al., 2021; Iacus et al., 2012). CEM is a methodological approach that facilitates the creation of comparable groups by balancing covariates between treated and control samples (Iacus et al., 2012).

Table 4. Robustness test results: The effect of sustainability on firm value

Variables	*(1) ROA*
SNB	0.001
	(1.090)
FZ	-0.001
	(-0.899)
LEV	0.004
	(0.147)
FA	0.000**
	(2.107)
_cons	0.058***
	(6.285)
Year fixed effects	Yes
r2	0.017
r2_a	0.007
N	815

*Note: t-statistics in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

The analysis utilizes 815 observations, offering an adequately large sample size for conducting robustness testing. As presented in Table 4, the robustness test results reveal a weak association between *SNB* and *ROA*. The coefficient for *SNB* is 0.001, with a t-statistic of 1.090, indicating that *SNB* has a minimal influence on *ROA*. A p-value exceeding 0.1 suggests that the impact of sustainability on firm performance is not statistically significant. These results support and reinforce the findings of the main regression analysis, confirming that *SNB* does not have a significant effect on *ROA*.

Table 5. Robustness test results: The effect of sustainability on firm value with innovation as a moderating variable

Variables	*(1) ROA*
SNB × RND	0.728***
	(2.867)
SNB	0.001
	(1.029)
RND	-1.119*
	(-1.730)
FZ	-0.001
	(-0.954)
LEV	0.006
	(0.239)
FA	0.000**
	(2.007)
_cons	0.059***
	(6.246)
Year fixed effects	Yes
r2	0.026
r2_a	0.014
N	815

*Note: t-statistics in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

Meanwhile, Table 5 presents the robustness test results, showing that the *SNB* variable has a coefficient of 0.001 with a t-statistic of 1.029, indicating that sustainability does not exert a statistically significant effect on *ROA*. However, the interaction term between sustainability and *RND* (*SNB × RND*) yields a coefficient of 0.728 with a t-statistic of 2.867, which is significant at the 1% level. These findings are consistent with the main regression results, thereby confirming that the model is robust in explaining how innovation can enhance the relationship between sustainability and firm value.

5. DISCUSSION

Numerous prior studies have investigated the link between sustainability and firm value; however, the results frequently show inconsistencies. Zhou et al. (2022) discovered that firms engaging in sustainable practices generally perform better in the market, as they are viewed as having effective risk management and a strong focus on long-term sustainability. Additionally, Saleh (2020) concluded that sustainability can create long-term value for shareholders, especially when it is regarded as a strategic approach to managing social and environmental risks. Conversely, a considerable number of studies indicate that sustainability does not consistently exert a meaningful influence on firm value. For example, Nguyen (2020) suggested that the costs linked to sustainability reporting often surpass its immediate advantages, particularly in markets that lack strong support for sustainable initiatives. Likewise, Ammer et al. (2020) found that sustainability has no significant impact on firm value in Indonesia, especially when sustainability practices are not thoroughly embedded within the core business strategy. This study supports those findings by demonstrating that *SNB* holds an insignificant coefficient in relation to *ROA*, which is used as the proxy for firm value. These results are in line with the perspective that sustainability, when not accompanied by additional reinforcing factors, has yet to make a significant contribution to firm value in the Indonesian context.

The moderating variable in this research is innovation, which is measured using *RND* expenditure. The purpose of *RND* as a moderating variable is to assess whether investment in innovation can amplify the effect of sustainability on firm value. Several prior studies support the notion that innovation holds a critical role in this relationship. For example, Lopes et al. (2022) showed that innovation driven by sustainability efforts can strengthen a firm's competitive advantage, ultimately leading to a positive impact on firm value. Similarly, Dai and Xue (2022) found that innovation helps firms reduce environmental costs and improve long-term competitiveness, ultimately leading to an increase in firm value. However, Ammer et al. (2020) argue that innovation does not always strengthen the relationship between sustainability and firm value, particularly when it is not supported by an effective strategy. In some cases, poorly implemented innovation may even reduce the potential benefits of sustainability on firm value. This study found that the interaction between *SNB* and *RND* has a positive and statistically significant coefficient in relation to *ROA*, indicating that *RND* enhances the impact of sustainability on firm value. The positive coefficient reflects a synergistic effect between *SNB* and *RND*, suggesting that investment in sustainability, when combined with innovation through *RND*, can contribute to increasing a firm's value. In this context, the main role of innovation is to generate added value, which can be seen through improvements in operational efficiency and

the implementation of environmentally friendly technologies. Although the interaction term between *SNB* and *RNB* is statistically significant, its economic magnitude is also noteworthy. A coefficient of 0.728 indicates that a unit increase in innovation amplifies the effect of sustainability on *ROA* by 78 basis points. Given the average *ROA* in the sample is only 6.7%, this suggests a 11.6% relative improvement, which is substantial in a developing economy context like Indonesia, where even marginal improvements in profitability are critical for growth and investor appeal (Dai & Xue, 2022; Kılıç et al., 2022).

This study offers valuable insights for companies, showing that innovation enables firms to lower long-term operational costs and better respond to markets that are becoming increasingly conscious of sustainability concerns. Moreover, innovation drives firms to develop more competitive products and services, enabling them to better position themselves in the global market (Sahetapy, 2023). Innovation provides a strong foundation to support sustainability, as it enables companies to integrate social responsibility into their business processes. Through *RND*, firms can explore new methods and products that not only promote sustainability but also enhance their corporate image in the eyes of stakeholders, hence increasing firm value. This is supported by the findings of Chen and Liu (2019), who demonstrated that environmentally friendly innovation positively impacts a company's competitiveness and enhances its value in a competitive market. Innovation in sustainability not only yields environmental benefits but also has a positive impact on operational efficiency and investor appeal, which contributes to improving firm value.

6. CONCLUSION

This study seeks to investigate the moderating role of innovation in the relationship between sustainability and firm value, focusing on publicly listed companies in Indonesia. The findings reveal that sustainability does not have a statistically significant direct impact on firm value, leading to the rejection of *H1*. However, when sustainability is combined with innovation as a moderating variable, a significant positive effect on firm value emerges, supporting *H2*. The integration of sustainability and innovation has been shown to improve operational efficiency and strengthen competitiveness, thereby providing greater benefits to firm value. This research offers both theoretical and practical contributions. Theoretically, it enriches the literature by highlighting the role of innovation as a moderating variable in the sustainability–firm value relationship. The findings emphasize the importance of adopting strategies that integrate sustainability with innovation to maximize results. Practically, the study offers insights for corporate leaders, suggesting that sustainability alone may be insufficient to drive firm value. A more integrated approach involving innovation is needed to achieve operational improvements and competitive advantage. Furthermore, this study provides a basis for policymakers to develop regulations that encourage investment in innovation as part of corporate sustainability initiatives. Policies supporting the advancement of environmentally friendly technologies can enhance firms' competitiveness in the global marketplace.

Nevertheless, this study has several limitations. Firstly, its geographical scope is confined to companies listed on the IDX, which may limit the generalizability of the findings to broader international contexts. Second, innovation is measured solely through R&D expenditure, which may not fully capture the various dimensions of corporate innovation, such as product or process innovation. Third, the research period, limited to 2018–2022, restricts the ability to observe longer-term trends, particularly those influenced by regulatory changes or economic conditions. Future research is recommended to expand the geographical scope, adopt more comprehensive measures of innovation, and longer study period using a longitudinal study. These steps would allow for a better understanding of the relationship between sustainability, innovation, and firm value, and yield broader insights for theory and practice.

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