

Institutional Ownership as Boundary Condition of Green Innovation and Firm Value in ASEAN

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Abstract

Purpose: This study examines the effect of financial performance on firm value with Green Innovation as a moderating variable and investigates the boundary role of Institutional Ownership as a second moderator (moderated moderation framework) in the ASEAN energy sector.

Research Methodology: A balanced panel dataset of 76 energy sector companies listed in six ASEAN countries (Indonesia, Malaysia, Thailand, the Philippines, Vietnam, and Singapore) for the period 2019–2024, yielding 456 observations, was utilized. Data were collected from Refinitiv.

Results: Without green innovation, financial performance ROA has a significant negative effect on firm value ($\beta = -0.0713$, $p = 0.0484$). Green innovation significantly and positively moderated this relationship ($\beta = +0.1125$, $p = 0.0035$). Institutional ownership is confirmed to be a critical boundary condition ($\beta = +0.1565$, $p = 0.0000$). Green innovation signals are activated only when institutional ownership exceeds 70.73%.

Conclusions: This study confirms the profitability paradox in the ASEAN energy sector: high profitability driven by geopolitical shocks does not enhance firm value unless it is accompanied by green innovation. Institutional ownership functions as an essential activation point that enables markets to interpret and value sustainability efforts.

Limitations: The sample is confined to six ASEAN countries and relies on Refinitiv and sustainability reports, which may not fully capture the differences between strategic and substantive green innovations.

Contributions: This study extends Signaling Theory by introducing institutional ownership as a signal receiver capacity', demonstrating that green innovation value creation requires a critical concentration of institutional monitoring (threshold: 70.73%).

Keywords: *Financial Performance, Firm Value, Green Innovation, Institutional Ownership, Moderated Moderation*

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1. Introduction

The ASEAN energy sector experienced severe macroeconomic disruptions from 2019 to 2024, driven by the COVID-19 pandemic in 2020–2021 and the Russia–Ukraine war in 2022, which simultaneously suppressed and artificially inflated company profitability (Fu & Shen, 2020; Ghosh, 2022; Makki & Alqahtani, 2023; Nerlinger & Utz, 2022; Shi, 2023; Yударuddin & Lesmana, 2026). Simultaneously, mandatory ESG requirements from the ASEAN Taxonomy for Sustainable Finance and regional stock

exchanges added structural transition pressures, compelling energy companies to realign their strategies toward sustainability ([Putri, Husni, & Adrianto, 2025](#); [Tripopsakul, 2025](#)).

A critical empirical paradox emerged from these field conditions: during 2022–2023, surging commodity prices boosted the ROA of ASEAN energy companies to record highs, yet firm value (Tobin's Q) did not increase proportionally ([Asni & Agustia, 2022](#); [Devi et al., 2024](#); [Husnaini & Tjahjadi, 2021](#)). Markets dismissed these profits as transitory, penalizing firms that failed to reinvest in sustainable operations amid tightening environmental regulations ([Diantini, Darmayanti, & Candraningrat, 2023](#); [Mar'ati & Darsono, 2022](#)). This evidence reveals a critical research gap: non-financial variables must be integrated to explain firm value formation in the post-pandemic energy sector.

Prior research confirms that green innovation moderates the ROA-firm value relationship; however, most studies assume that markets interpret environmental signals homogeneously ([Aghion, Van Reenen, & Zingales, 2013](#); [Miller, Qiu, Wang, & Yang, 2022](#)). A critical unresolved question remains: which investors possess the capacity to validate green innovation signals and convert them into firm value? This study proposes that institutional ownership serves as a boundary condition, as institutional investors possess the analytical sophistication to distinguish substantive green innovation from greenwashing ([Liu, Liu, & Feng, 2024](#)). Therefore, the effectiveness of green innovation signals is critically contingent on the concentration of institutional ownership.

This study examines the effect of financial performance on firm value in ASEAN energy companies, with green innovation as the first moderator and institutional ownership as the second moderator, using PROCESS Macro ([Igartua & Hayes, 2021](#)) Model 3. Three contributions are made: theoretically, it extends Signaling Theory by introducing institutional ownership as signal receiver capacity ([Sari, Akhmadi, & Ichwanuddin, 2023](#)) practically, it identifies a precise institutional ownership threshold activation point for ASEAN energy firm management and stock exchange regulators; and empirically, it employs comprehensive longitudinal panel data from 2019–2024 across six ASEAN countries capturing pandemic and geopolitical dynamics.

2. Literature Review

2.1 Theoretical Framework and Variable Relationships

This study integrates signaling and agency theories as dual theoretical foundations. Signaling Theory posits that firms reduce information asymmetry by transmitting high-quality non-financial signals to capital markets ([Sari et al., 2023](#)), where the Green Innovation Score functions as a credible signal of long-term risk mitigation and sustainable competitive advantages ([Chouaibi, Chouaibi, & Rossi, 2022](#); [Xie, Huo, & Zou, 2019](#)). This study extends Signaling Theory by proposing that institutional ownership represents the signal receiver capacity of institutional investors with sophisticated analytical capabilities to absorb green innovation signals and transform them into positive investment decisions that elevate firm value ([Miller et al., 2022](#)). Complementing this, Agency Theory posits that institutional ownership mitigates agency conflicts between managers and shareholders ([Jensen & Meckling, 2019](#)), creating active monitoring mechanisms that align management interests with long-term shareholders ([Aghion et al., 2013](#); [Sakawa & Watanabel, 2020](#)), ensuring green innovation investments are implemented substantively rather than superficially and enhancing the credibility of environmental signals in the public domain ([Budiman, Yadiati, & Hasyir, 2024](#); [Zheng, Khurram, & Chen, 2022](#)).

2.2 Research Gap and Propositions

Empirically, ROA and firm value (Tobin's Q) exhibit a paradoxical relationship in environmentally sensitive industries: high profitability from conventional fossil fuel exploitation signals long-term risk rather than future sustainability, as markets anticipate carbon taxes, environmental litigation, and energy transition pressures ([Abedin, Haque, Shahjahan, & Kabir, 2022](#); [Nerlinger & Utz, 2022](#); [Suyanto & Bilang, 2023](#)). Green innovation moderates and reverses this negative relationship, measured across eight dimensions, including product innovation, process innovation, R&D investment, environmental certification, and sustainability reporting, signaling a firm's commitment to sustainability and ensuring long-term value creation aligned with the ASEAN Taxonomy for Sustainable Finance ([Andries &](#)

[Stephan, 2019](#); [Asni & Agustia, 2022](#); [Husnaini & Tjahjadi, 2021](#); [Srouji, Hamdallah, Al-Hamadeen, Al-Okaily, & Elamer, 2023](#); [Tripopsakul, 2025](#); [Xie et al., 2019](#)).

However, green innovation signals are only effective when institutional ownership is sufficiently concentrated: at low levels, signals are ignored by retail investors lacking long-term horizons; at dominant concentration, institutional investors activate monitoring per Agency Theory principles, ensuring ROA allocations flow into green innovation and bestowing credibility to global markets ([Aghion et al., 2013](#); [Chabachib, Fitriana, Hersugondo, Pamungkas, & Udin, 2019](#); [Hidayat, Ismail, Taqi, & Yulianto, 2023](#); [Manurung, 2022](#); [Miller et al., 2022](#); [Putri et al., 2025](#); [Sakawa & Watanabel, 2020](#)). Based on this reasoning, this study proposes the following hypotheses: (1) financial performance (ROA) significantly affects firm value (Tobin's Q); (2) green innovation positively moderates the relationship between ROA and Tobin's Q; and (3) institutional ownership functions as a critical boundary condition that strengthens the moderating effect of green innovation on the ROA–Tobin's Q relationship.

3. Methodology

3.1 Research Design

This study employed a quantitative approach with a longitudinal explanatory design to test the causal relationships and interactions among variables in a complex conditional model. Panel data analysis was applied to observe the same analytical units across time, which is deemed most accurate for capturing shifts in capital market behavior before, during, and after a series of global shocks in the 2019–2024 observation period.

3.2 Population, Sample, and Data

The population comprises all publicly listed companies operating in the energy sector on the stock exchanges of ASEAN member states. Purposive sampling was applied with the following strict criteria: (1) companies consistently listed on the stock exchanges of six major ASEAN countries—Indonesia (IDX), Malaysia (Bursa Malaysia), Thailand (SET), Philippines (PSE), Vietnam (HOSE/HNX), and Singapore (SGX)—throughout 2019–2024; (2) companies that published complete annual reports and sustainability reports consecutively; and (3) companies with consistently recorded ESG indicator and ownership structure data in the Refinitiv Eikon database. Based on these criteria, a final sample of 76 energy companies was selected. With a six-year observation period, the total balanced panel observations for the analysis amounted to 456. All secondary data were extracted from Refinitiv Eikon.

3.3 Data Analysis Method

To test the dual moderation regression model (moderated moderation or three-way interaction), this study employed the PROCESS Macro developed by ([Hayes & Rockwood, 2017](#)), specifically using Model 3. This model simultaneously estimates the interaction between the independent variable and two moderating variables and provides precise conditional effect estimates at various moderator levels. To address the heteroskedasticity commonly present in cross-country panel data in the energy sector, all coefficient estimates were computed using the HC0 Robust Standard Errors covariance matrix estimation ([Wooldridge, 2016](#)). The structural econometric equation for Model 3 is formulated as follows:

$$Y = \beta_0 + \beta_1 X + \beta_2 W + \beta_3 (X \times W) + \beta_4 Z + \beta_5 (X \times Z) + \beta_6 (W \times Z) + \beta_7 (X \times W \times Z) + \varepsilon \quad (1)$$

Where Y represents Tobin's Q, X represents ROA, W represents the Green Innovation Score; Z represents Institutional Ownership, (X×W) is the two-way interaction of the first moderation, (X×Z) and (W×Z) are control interactions, and (X×W×Z) is the three-way interaction determining the presence of moderated moderation. Significance boundary testing uses the Pick-a-Point technique at mean, –1 Standard Deviation (SD), and +1 SD levels to identify the signal activation threshold.

4. Results and Discussions

4.1 Descriptive Statistics

A descriptive statistical analysis was conducted to provide an overview of the distribution, minimum, maximum, mean, and standard deviation of all variables tested across 456 observations of ASEAN energy sector companies. The descriptive statistics of all variables are presented in Table 1.

Table 1. Descriptive Statistics

Variables	Minimum	Maximum	Mean	Std. Deviation
Firm Value (Tobin's Q)	0.01	13.41	0.8874	1.39836
Financial Performance (ROA)	-35.57	67.33	5.3047	11.67042
Total Asset (Ln)*	17.85	32.75	26.3331	4.03086
Firm Age (Years)*	4.00	148.00	33.43	23.43
Green Innovation (GI Score)	0.50	1.00	0.9287	0.14682
Institutional Ownership (IO %)	69.57	94.71	71.10	3.998

Based on Table 1, the firm value variable (Tobin's Q) shows a wide variation, with a minimum of 0.01 and a maximum of 13.41, and a mean of 0.8874. A mean below 1.00 indicates that, in general, ASEAN energy sector firm assets are valued by the market below their book value, a common condition for capital-intensive conventional industries undergoing energy transition. The financial performance variable (ROA) recorded a mean of 5.3047% but exhibited an extremely wide deviation range from a low of -35.57% to a high of 67.33%, reflecting severe revenue volatility caused by the dual disruption of collapsing oil prices during the early COVID-19 pandemic and unexpected windfall profits during the energy crisis triggered by the Russia-Ukraine war. The mean Green Innovation Score is very high at 0.9287, with a small standard deviation (0.14682), indicating that ASEAN energy companies have formally adopted green innovation dimensions in their operations in response to stock exchange regulations. Finally, institutional ownership (IO) averages 71.10%, confirming that the capital structure of ASEAN energy firms is dominated by large institutional investors, with a range of 69.57%-94.71%.

4.2 Multicollinearity Test

Prior to hypothesis testing, multicollinearity was examined using Pearson correlation matrix analysis to ensure the absence of excessively strong linear correlations among independent variables that could introduce bias into the regression estimates. The Pearson correlation matrix is presented in Table 2.

Table 2. Pearson Correlation Matrix

Variables	Tobin's Q	ROA	GI Score	Inst. Ownership	Total Asset*
Tobin's Q	1.000				
ROA	-0.114	1.000			
GI Score	0.052	0.036	1.000		
Inst. Ownership	0.184	0.268	0.018	1.000	
Total Asset*	-0.092	0.267	0.045	0.294	1.000

Based on the correlation results in Table 2, all the correlation coefficients among the main variables were below 0.30. The correlation between ROA and GI Score is 0.036; between ROA and institutional ownership is 0.268; and between green innovation and institutional ownership is at a very low level of 0.018. Since none of the inter-variable correlation coefficients approach or exceed the critical threshold of 0.70, it can be conclusively established that this regression model is free from serious multicollinearity, thus validating the subsequent moderation testing.

4.3 Model 1: Green Innovation Moderation

The first stage of hypothesis testing estimated Model 1, examining the direct effect of financial performance on firm value, along with the moderating interaction effect of green innovation, without involving institutional ownership. The regression coefficients of Model 1 are presented in Table 3.

Table 3. Model 1 Regression Coefficients — Green Innovation Moderation

Variables	Coeff	SE	t	p	LLCI	ULCI
Constant	1.0848	0.4349	2.4943	0.0130	0.2301	1.9394
ROA (X)	-0.0713	0.0360	-1.9793	0.0484	-0.1422	-0.0005
Green Innovation (W)	-0.4094	0.4643	-0.8818	0.3784	-1.3219	0.5031
Int_1 (ROA × GI)	+0.1125	0.0383	2.9364	0.0035	0.0372	0.1878

The summary and conditional effects of Model 1 are presented in Table 4.

Table 4. Model 1 Summary and Conditional Effects

Statistic	R	R ²	MSE	F	df1	df2	p
Model Fit	0.3082	0.0950	1.7814	15.8184	3	452	0.0000
Interaction Test (X×W)	ΔR ² =0.0173			F=8.6222	1	452	0.0035
Conditiona l: GI=0.8750	Effect=0.0271	SE=0.0058	t=4.7015	p=0.0000	LLCI=0.0157	ULCI=0.0384	
Conditiona l: GI=1.0000	Effect=0.0412	SE=0.0060	t=6.8668	p=0.0000	LLCI=0.0295	ULCI=0.0530	

The results of Model 1 in Tables 3 and 4 provide crucial empirical confirmation. The regression coefficient for ROA is $\beta = -0.0713$ with significance $p = 0.0484$ ($p < 0.05$), and a confidence interval that does not cross zero (LLCI = -0.1422, ULCI = -0.0005). This means that when green innovation is zero or ignored, an increase in ROA has a significantly negative impact on firm value (Tobin's Q). Therefore, the first proposition was supported. The theoretical basis of this result reflects market skepticism toward the 'gross profits' of the conventional energy sector unaccompanied by long-term environmentally responsible investment.

Subsequently, testing the first interaction effect (Int_1: ROA × GI) reveals a positive coefficient of $\beta = +0.1125$ with a very strong significance of $p = 0.0035$ ($p < 0.01$). This interaction contributes an incremental coefficient of determination (ΔR^2) of 0.0173 with $F = 8.6222$ ($p = 0.0035$). This proves that green innovation significantly moderates and reverses the influence of ROA on firm value from negative to positive. Based on the conditional effects data in Table 4, when GI is at a low level (0.8750), the effect of ROA on firm value is 0.0271 ($p = 0.0000$). This effect increases sharply to 0.0412 ($p = 0.0000$) when green innovation is fully implemented at the maximum level (1.0000). Therefore, the second proposition is supported. Green innovation functions as an effective operational-signal modifier for investors.

4.4 Model 3: Moderated Moderation - Institutional Ownership

The next critical step is to test the full integrative model through Model 3, incorporating institutional ownership as the second moderator conditioning the effectiveness of green innovation, forming a three-way interaction. The complete Model 3 regression coefficients are presented in Table 5.

Table 5. Model 3 Complete Regression Coefficients

Variables	Coeff	SE	t	p	LLCI	ULCI
Constant	-88.2821	13.9982	-6.3067	0.0000	-115.7924	-60.7718
ROA (X)	+10.7036	1.7833	6.0022	0.0000	7.1990	14.2083
Green Innovation (W)	+89.0928	14.5070	6.1414	0.0000	60.5826	117.6031
Int_1 (ROA × GI)	-10.9462	1.7986	-6.0859	0.0000	-14.4810	-7.4114

Inst. Ownership (Z)	+1.2683	0.1985	6.3882	0.0000	0.8781	1.6585
Int_2 (ROA × IO)	-0.1526	0.0253	-6.0352	0.0000	-0.2023	-0.1029
Int_3 (GI × IO)	-1.2704	0.2058	-6.1742	0.0000	-1.6748	-0.8660
Int_4 (ROA × GI × IO)	+0.1565	0.0255	6.1371	0.0000	0.1064	0.2066

The structural regression equation based on the estimates in Table 5 is as follows:

$$Tobin's Q = -88.2821 + 10.7036 ROA + 89.0928 GI - 10.9462(ROA \times GI) + 1.268 IO - 0.1526(ROA IO) - 1.2704(GI \times IO) + 0.1565(ROA \times GI \times IO) \quad (2)$$

The Model 3 summary and highest-order interaction test are presented in Table 6.

Table 6. Model 3 Summary and Highest-Order Interaction Test

Statistic	R	R ²	MSE	F	df1	df2	p
Model Fit	0.4468	0.1996	1.5895	15.9649	7	448	0.0000
Three-Way Interaction (X×W×Z)	ΔR ² =0.0673			F=37.6639	1	448	0.0000

Based on Tables 5 and 6, the three-way interaction coefficient (Int_4: ROA × GI × IO) shows a highly significant positive coefficient of $\beta = +0.1565$ ($p = 0.0000$, $p < 0.001$), which is supported by a robust confidence interval (LLCI = 0.1064 to ULCI = 0.2066). Incorporating the institutional ownership interaction substantially increases the explanatory power of the model, evidenced by $\Delta R^2 = 0.0673$ with $F = 37.6639$ ($p = 0.0000$), the largest ΔR^2 among all models tested. This empirically confirms that institutional ownership functions as a boundary condition variable that significantly strengthens the moderating effect of green innovation on the ROA-Tobin's Q relationship. The conditional effects of the ROA×GI interaction at varying levels of institutional ownership are presented in Table 7.

Table 7. Conditional Effects of ROA×GI Interaction at Levels of Institutional Ownership

IO Level	Moderation Effect	F	df1	df2	p
IO = 69.73% (-1 SD, Low)	-0.0364	0.7319	1	448	0.3927
IO = 69.88% (Mean)	-0.0123	0.0903	1	448	0.7640
IO = 70.73% (+1 SD, High)	+0.1199	10.1462	1	448	0.0015

The findings in Table 7 represent the most important theoretical insights of this study. When institutional ownership is at a low level of 69.73% (-1 SD) and at the sample mean of 69.88%, the moderation interaction effect values are -0.0364 ($p = 0.3927$) and -0.0123 ($p = 0.7640$), respectively, both of which are proven statistically non-significant. This indicates that below a certain institutional ownership threshold, green innovation signals sent by companies are not responded to by the market and lose their capacity to moderate the financial performance. This moderation effect only becomes active, positive, and highly significant when the institutional ownership concentration surpasses the critical threshold of 70.73% (+1 SD), with the moderation coefficient jumping to +0.1199 ($p = 0.0015$; $p < 0.01$). Therefore, the third proposition is supported. The figure of 70.73% represents the activation point at which institutional ownership successfully creates an effective environmental signal-receiving capacity in ASEAN capital markets. The conditional effects of ROA on Tobin's Q at the combined levels of GI and IO are presented in Table 8.

Table 8. Conditional Effects of ROA on Tobin's Q at Combined Levels of GI and IO

Green Innovation (GI)	Institutional Ownership (IO)	Effect	SE	t	p
GI = 0.875 (Low)	IO = 69.73% (Low)	0.0312	0.0066	4.7225	0.0000
GI = 0.875 (Low)	IO = 70.73% (High)	0.0155	0.0058	2.6787	0.0077
GI = 1.000 (High)	IO = 69.73% (Low)	0.0267	0.0070	3.7851	0.0002
GI = 1.000 (High)	IO = 70.73% (High)	0.0305	0.0064	4.7905	0.0000

The data in Table 8 show that the combination of maximum green innovation (1.000) and institutional ownership above the threshold (70.73%) yields a robust and highly significant positive conditional effect of financial performance on firm value enhancement (effect = 0.0305, $t = 4.7905$, $p = 0.0000$). Figure 1 visually illustrates this interaction pattern through a three-panel conditional effects plot.

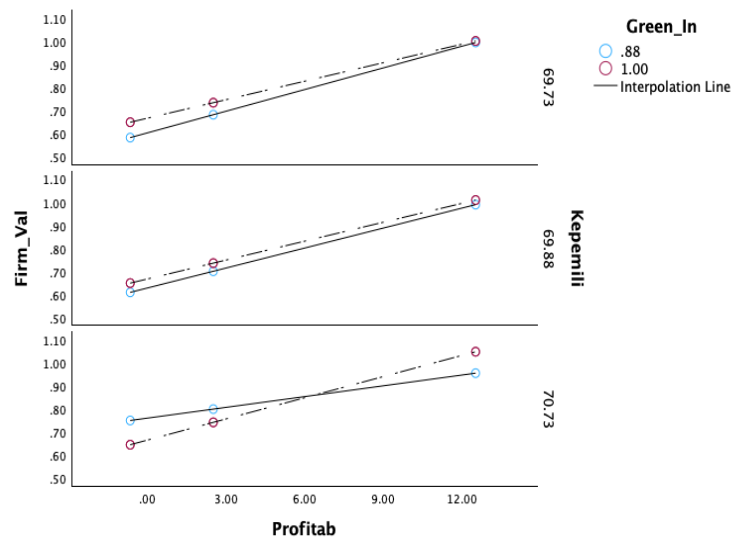


Figure 1. Conditional Effects of ROA on Tobin's Q at Varying Levels of GI Score and Institutional Ownership

The horizontal axis (X) represents profitability (ROA), and the vertical axis (Y) represents firm value (Tobin's Q). The solid blue line represents low green innovation (GI = 0.88), and the dotted red line represents high green innovation (GI = 1.00). In the upper panel (IO = 69.73%) and middle panel (IO = 69.88%), both lines run nearly coincident and are almost identical, confirming the absence of any meaningful differential impact of green innovation at low institutional ownership levels. However, the visualization changes dramatically in the lower panel (IO = 70.73%), where the two lines begin to diverge significantly. The dotted red line (GI = 1.00) is positioned significantly above the solid blue line (GI = 0.88), with the widest separation gap occurring at high profitability levels (approximately 12.00). This visual pattern confirms that the higher the institutional ownership, the greater the distance between the high-GI and low-GI lines, confirming that institutional ownership activates the signal capacity of green innovation in enhancing firm value.

4.5 Integrative Discussion

The integration of empirical findings reveals highly rational and selective behavior by ASEAN capital markets toward energy sector issuers throughout the dynamic period 2019–2024, drawn from six major energy markets: Indonesia, Malaysia, Thailand, the Philippines, Vietnam, and Singapore, representing the region's most significant capital markets and energy producers. The market's rejection of ROA without green innovation is rooted in the macroeconomic volatility of the observation period. During 2022–2023, the Russia–Ukraine war triggered a commodity price surge, causing unexpected windfall profits in ASEAN energy companies' income statements (Yudaruddin & Lesmana, 2026). However, market participants understood that these profits were transitory and driven by external geopolitical factors, not internal structural efficiency improvements (Nerlinger & Utz, 2022). Investors were concerned that high profitability from conventional fossil energy would increase companies' exposure to future environmental penalty risks amid the tightening of the ASEAN Taxonomy post-2024 (Putri et al., 2025).

This conceptualization undergoes a complete reversal when green innovation is incorporated as the first moderating variable. When firms reinvest profits into green innovation — restructuring low-emission production processes, allocating green R&D, or achieving international certifications—these activities function as credible quality signals consistent with Signaling Theory (Sari et al., 2023). Green innovation signals communicate that the firm possesses strong defensive strategies to mitigate climate

risk, transforming energy transition threats into growth opportunities (Chouaibi et al., 2022). The reinvestment of profitability into green innovation validates that the energy firm is a future-competitive leader, prompting the market to respond positively by elevating stock prices and firm value (Asni & Agustia, 2022).

The most original theoretical contribution lies in proving the role of institutional ownership as the second moderator in establishing the operational threshold for environmental signals. As illustrated in Figure 1 and detailed in Tables 7 and 8, green innovation signals cannot be instantly comprehended by markets dominated by retail investors with limited information capacity. This study proves mathematically that a minimum institutional ownership concentration of 70.73% is required to function as an effective signal receiver capacity (Miller et al., 2022). Large-scale institutional investors above this threshold conduct independent audits of corporate ESG claims, ensuring that ROA allocations genuinely flow into substantive green innovation rather than greenwashing (Liu et al., 2024).

Consistent with Agency Theory, institutional ownership above 70.73% confers dominant voting power to reduce information asymmetry and ensure consistent green governance (Aghion et al., 2013). When institutions dominate ownership above this threshold, their presence legitimizes global markets, converting sustainability signals into significant market value appreciation (Chabachib et al., 2019). These findings reinforce (Devi et al., 2024) regarding the necessity of redefining firm value determinants in the post-pandemic era by integrating modern ownership structures with ESG indicators.

5. Conclusions

5.1 Conclusion

This study successfully delineates the market valuation behavior of energy sector companies across six ASEAN countries during the dynamic period of 2019–2024. Empirical testing confirms the existence of a profitability paradox, whereby conventional financial performance (ROA) alone, without sustainability commitment, negatively impacts firm value (Tobin's Q), reflecting investors' concerns over long-term energy transition risks ($\beta = -0.0713$, $p = 0.0484$). The introduction of green innovation as a moderating variable reverses this negative impact into a significant positive influence ($\beta = +0.1125$, $p = 0.0035$), affirming that environmentally based investment strategies function as credible operational quality signals in the market. Most crucially, this study confirms the moderated moderation model by proving that institutional ownership functions as a critical boundary condition ($\beta = +0.1565$, $p = 0.0000$). The positive reversal effect of green innovation on the ROA-Tobin's Q relationship does not occur automatically but requires institutional ownership to be present above the critical threshold (activation point) of 70.73%. Below this figure, green innovation signals lose their value in the market. Theoretically, this study successfully extends Signaling Theory by introducing the signal receiver capacity concept conditioned by institutional ownership concentration.

5.2 Research Limitations

This study had several limitations that must be acknowledged. First, the geographical scope of the sample is limited to six ASEAN countries; therefore, the generalization of findings to other developing regions with different institutional characteristics must be undertaken with caution. Second, green innovation assessment uses the Refinitiv Eikon ESG secondary database Green Innovation Score, which, while objective, may contain observer bias and is heavily dependent on the quality of companies' formal disclosures. Third, the 2019–2024 observation period encompasses extremely severe macroeconomic distortions from the COVID-19 pandemic crisis to commodity price anomalies caused by the Russia–Ukraine war, which may create temporal outlier effects in accounting profitability records. Finally, this model is not yet capable of definitively separating the long-term operational impact of substantive green innovation activities from that of purely strategic or cosmetic green innovation.

5.3 Suggestions and Directions for Future Research

Based on the identified limitations, several recommendations are proposed for future studies. Subsequent studies should expand the sample scope by including developing countries outside the ASEAN region or in East Asia to compare the universal validity of institutional ownership thresholds.

Green innovation measurement methods should be developed by adopting deep content analysis or machine learning algorithms to definitively separate substantive from strategic (cosmetic) green innovation. Future researchers are also encouraged to explore mediation mechanisms, such as testing whether green innovation influences firm value indirectly through enhanced corporate reputation or reduced capital costs. Finally, it is recommended to expand the conditional model by adding other internal governance variables as supporting moderators, such as board independence and foreign ownership proportion.

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Author Contributions

WSGRD contributed to the conceptualization, data curation, formal analysis, methodology, writing, original draft, review, and editing. IW contributed to supervision, conceptualization, writing, review, and editing. NN contributed to supervision, methodology, writing, review, and editing. MS contributed to supervision and writing, review, and editing. RMP contributed to data curation, formal analysis, writing, review, and editing.

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