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The Effect Of Corporate Financial Performance, Firm Size, and Firm Age on Firm Value with Climate Change Disclosure as A Moderator

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ABSTRACT
This study investigates the effect of corporate financial performance, firm size, and firm age on firm value with the implementation of climate change disclosures as a moderating variable, utilizing stakeholder theory. Climate change disclosure (CCD) as recommended by the Task Force on Climate-related Financial Disclosures (TCFD) serves as a moderating variable, which is a novelty in this study. The samples include 16 energy sector companies listed on the Indonesia Stock Exchange (IDX) between 2019 and 2023, selected through purposive sampling and analyzed by panel data regression and moderated regression. The analysis results exhibit that ROA has a positive effect on firm value, ROE has a negative effect on firm value, and firm size and firm age have no effect on firm value. CCD weakens the effect of ROA and strengthens the effect of ROE on firm value, but does not moderate the effect of firm size and firm age on firm value.

Keywords:
Corporate Financial Performance, Firm Size, Firm Age, Firm Value, Climate Change Disclosure.

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INTRODUCTION

The firm's overall productivity is captured in firm value and perceived by the market, weighing both financial along non-financial perspectives. This matter is crucial because it influences the decisions of stakeholders who rely on the firm's economic, ecological, and societal outcomes. Companies are expected to generate profits that align with the risks stakeholders take on. Factors like profitability, assets, and business experience help stakeholders gauge the trade-off between risk and return. However, climate change presents new challenges that could affect investment evaluations and make a company's market value more unpredictable.

The severe climate change consequences, consisting of rising heat, surging sea levels, alongside intensified weather catastrophes, are becoming more evident. A striking example is the "micro-scale tornado" that hit Rancaekek, Bandung, in 2024, damaging 18 factories (CNN Indonesia 2024), disrupting supply chains, and affecting business operations. Companies exposed to such events face heightened risks, increased costs, and growing concerns, particularly those heavily exposed to climate-related factors. These challenges can significantly lower their market value (Berkman et al. 2024).

According to UU RI No. 16/2016 about the Paris Agreement Ratification to the UNFCCC, Indonesia faces geographical climate change risks but has great potential for mitigation. As the country with the largest urban population in ASEAN, energy consumption and carbon emissions are high (Tan & Hong 2020), while emissions continue to rise (OECD 2023). The Enhanced NDC 2022 targets 31.89% unconditional and 43.20% conditional emission reductions, with a focus on sustainable agriculture, climate adaptation, and climate-resilient technologies (OECD 2023; *Enhanced* NDC Indonesia 2022). Climate change and related regulation inconsistencies can increase costs, unpredictability, alongside volatility in a firm's market valuation (Naseer et al. 2024; Ren et al. 2024).

Insufficient information regarding economic impacts from climate-related events can trigger global market volatility, financial shocks, and sudden asset losses (Harper Ho 2018). Climate change that worsens companies' production processes threatens profitability (Naseer et al. 2024), increases funding risks, and creates uncertainty for stakeholders. Uncertainty related to physical and regulatory risks also drives market value volatility and reassessment of investment portfolios by investors (Naseer et al. 2024). Climate change is driving companies to create new models that are aligned with social and environmental responsibility (Clarke 2019). Consequently, organizations publish sustainability reports to improve their operational, social, economic, and environmental performance while building long-term relationships with stakeholders (Petrescu et al. 2020). These reports help stakeholders approximate the possibility of difficulties and advantages linked to climate change impacts. The TCFD recommendations support zero-carbon policies by providing a profound insight into challenges and prospects linked to climate change (O'Dwyer et al. 2020). Combining the GRI framework, widely used in Indonesia, with the TCFD framework can improve the quality of sustainability reports, standardize climate-related communication, enable more accurate risk pricing, and promote better capital allocation (Boiral et al. 2019). TCFD reporting is needed to improve climate-related financial information through policy reform, strategy adaptation, data availability, and alignment of sustainability initiatives (Achenbach et al. 2021).

The use of TCFD frameworks increased globally from 63% to 71% in 2021-2022, especially in Asia, Brazil, Russia, South Africa, and Spain (IFAC 2024). In Indonesia, only 10% of listed companies in IDX are implementing TCFD, a 4% increase since 2021, placing Indonesia as the 2nd country with the lowest awareness regarding the disclosure of risk and opportunity connected to climate change in the Asia Pacific (Eu-Lin & Loh 2023). TCFD has the potential to improve corporate sustainability accountability but requires further research to overcome challenges and improve its implementation (O'Dwyer et al. 2020).

In Indonesia, studies concerning the financial performance, size, and age effects on firm value often focus on carbon emission disclosure related to climate change. Results vary: Hapsoro & Falih (2020) found that firm size positively affects firm value, while ROA does not, and carbon emission disclosure enhances ROA's effect but weakens size's impact. Putri & Bawono (2023) reported ROA positively influences firm value, but the disclosure of

carbon emission has no effect on ROA and weakens size's impact. Abd Latif et al. (2023) observed that the food and beverage sector has a negative result on how firm size affects ROE but positively affects a firm's worth. However, carbon disclosure does not mediate these relationships.

The study conducted by Iriyadi and Antonio (2021) explored how climate change disclosure (CCD), using 11 indicators from the TCFD framework, impacted the financial performance of LQ45 companies between 2014 and 2018. The findings reveal that CCD does not have a linear effect on ROA. Instead, it shows a negative effect that becomes positive under certain pressures when analyzed through a non-linear approach. Among the indicators, Metrics & Targets achieved the highest CCD score. However, there was insufficient information on Risk Management, suggesting that businesses may have a limited understanding of climate change issues.

Based on those gaps, this paper analyzes how corporate financial performance, size, and age affect firm value, moderated by TCFD-aligned climate change disclosure. Tobin's Q was selected to assess long-term business value concerning the lasting effects of climate change (Vestrelli et al. 2024), while ROA and ROE were used to measure financial performance. Companies with sufficient resources and business experience can potentially utilize climate change disclosure for competitive advantage, increase profitability, and attract investors. Energy sector companies in 2019-2023 were chosen as objects because the sector is the 2nd largest GHG emitters in Indonesia (Climate Transparency 2022) that are sensitive to climate change impacts, has evolving regulations, and is important to the economy. The research period was chosen because, since 2019, sustainability reports have been obligatory for financial institutions, public companies, and issuers in accordance with POJK No. 51/POJK.03/2017. This study was carried out to address the research gaps due to inconsistencies in the results of earlier studies, offering new insights to bridge these gaps.

LITERATURE REVIEW

Stakeholder Theory

Freeman's (1984) stakeholder theory underlines the necessity for organizations to take into account all of the individuals or groups' interests altered by their actions and generate value for all stakeholders. These stakeholders, who are crucial to the organization's resources, include shareholders, employees, customers, suppliers, creditors, and communities. Companies must meet stakeholder expectations by recognising the impact of their decisions and devising strategies that integrate the interests of all involved parties to achieve everlasting success. Environmental information is important because business activities significantly affect stakeholders and the environment (Freeman 1984). The need for disclosing climate change-related information is rising due to its effects on stakeholder livelihoods and businesses. The environment is considered a key stakeholder due to its influence on infrastructure, resources and markets (Haigh & Griffiths 2009). Climate change pressures encourage companies to provide relevant information according to stakeholder expectations, such as the recommendations of the TCFD. Meeting these expectations can increase company value.

Variables Definition

Return on Assets

ROA assesses the manager's capability to manage funding, both debt and equity, to generate profits from available assets. This metric is important to investors as it reflects the efficiency of the company in utilizing assets for profit, which affects the share price (Christine & Winarti 2022). A high ROA indicates productive and efficient asset management, increasing investor confidence in high returns. Conversely, low ROA indicates less efficient asset management, lowering investor confidence and reducing investment attractiveness.

Return on Equity

ROE measures the effectiveness of managers in using shareholders' equity to generate profits. A high ROE indicates solid financial performance, boosts investor confidence, and triggers an uplift in share prices and the firm's overall valuation. A higher ROE demonstrates the firm's capacity for innovation and value generation to involved stakeholders (Asni & Agustia 2021).

Firm Size

Investors prefer securities of large companies because they are considered more profitable and

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have a lower risk of failure (Reinganum & Smith 1983). Large companies with larger assets tend to show good operational performance, provide more information, and actively manage risks (Alsharkas 2014; Dömötör 2023). The size of a firm positively impacts environmental, economic, and social performance, hence facilitating sustainability initiatives to mitigate externality concerns (Younis & Sundarakani 2019).

Firm Age

Firm age reflects resilience and ability to face business challenges. Longer-established companies are considered to have better risk management, more experience, and sufficient information than new companies, which tend to be prone to failure (Bloom et al. 2021). Long-established companies also demonstrate high productivity and transparency through complex annual reports.

Firm Value

Tobin's Q provides an assessment of the company's valuation through a ratio between its assets' market and book value. It reflects the overall assets, market sentiment, long-term value, and future potential (Aryandanu & Aisyah 2021; Vestrelli et al. 2024). A Q value above 1 suggests the company is overvalued, while a value below 1 implies that it is undervalued.

Climate Change Disclosure

Climate change disclosures are voluntary non-financial reports that provide information about risks, opportunities, and how climate change affects businesses. In 2015, the Financial Stability Board (FSB) initiated the TCFD recommendations to strengthen financial disclosures in response to climate change. The standard emphasizes four primary pillars: 1) Governance, 2) Strategy, 3) Risk Management, and 4) Metrics and Targets, and is designed to remain relevant across all sectors and industries (TCFD, 2017). These guidelines help investors, lenders, and insurers gain clearer insight into how climate change alters a business's financial resilience by embedding this information in annual reports when deemed material. The associated risks and opportunities within climate change that can influence a corporate's performance were categorized by the Task Force as follows:

Table 1. Climate Change Risks & Opportunities

Risk	Opportunities
Transition Risks: a. Policy and Legal b. Technology c. Market d. Reputation	a. Resource Efficiency b. Energy Source c. Products and Services d. Markets e. Resilience
Physical Risks: a. Acute b. Chronic	

Source: TCFD (2017)

Hypothesis Development
ROA on Firm Value

ROA assesses the firm's capability to optimize assets to yield profits according to investor expectations. When ROA is high, it signifies an efficient management of assets and higher profitability, which attracts investors because it provides a remarkable return (Harningsih et al. 2019; Prena & Muliyawan 2020). High profitability increases the company's valuation, as reflected in gains in stock prices that indicate attractive investments for stakeholders (Julito & Ticoalu 2022; Susilaningrum 2016). ROA also reflects managers' ability to manage resources effectively, which is important to maintain stakeholder trust and support business sustainability. Failure to manage resources can reduce the stakeholders' trust, leading to the decline of the company's worth and its business sustainability, according to the stakeholder theory that emphasizes the necessity of ensuring stakeholder expectations.

H_1: ROA has a positive effect on Firm Value

ROE on Firm Value

ROE measures the firm's capability to yield profits from shareholder-invested assets, reflecting the efficiency of managing equity to increase profitability (Setiawan & Kurnia 2024). A high

ROE indicates good financial health, which draws investors and increases firm value, evident in the ascending stock prices (Pradita & Suryono 2020: Ridwan et al. 2023). According to stakeholder theory, although shareholders are entitled to dividends, companies must be mindful of other stakeholders. Ignoring them may trigger penalties such as increased costs, difficult access to funding, and operational problems, which adversely affect shareholders. Conversely, fulfilling the expectations of all stakeholders will improve financial performance, profitability, therefore elevating the firm's valuation.

H_2: ROE has a positive effect on Firm Value

Firm Size on Firm Value

Firm size reflects how much assets are owned to generate profits. Large companies are perceived to have a low risk of failure, better access to resources, and superior operational performance, making them attractive to investors (Averchenkova et al. 2016; Hapsoro & Falih 2020). Large assets allow companies to focus on research, development, and scalability, supporting company growth (Knott & Vieregger 2018; Julito & Ticoalu 2022). As per stakeholder theory, large companies have a responsibility to manage assets to generate added value for stakeholders. Large assets also demand greater transparency and investment in sustainability to maintain stakeholder trust. By meeting their expectations, companies can boost profitability and enhance their firm value.

H_3: Firm Size has a positive effect on Firm Value

Firm Age on Firm Value

Company age reflects the capacity to endure and tackle business challenges. Long-established companies are perceived to be more reliable, have extensive business experience, and can manage risks and operational activities well, thereby increasing stakeholder trust and firm value (Julito & Ticoalu 2022). However, over time, older firms are at risk of declining growth, profitability, innovation, and flexibility, which can reduce their credibility and less appealing to investors (Coad et al. 2010; Loderer et al. 2016). Under the stakeholder theory, firms must meet stakeholder expectations. Failure to do so may lead to divestment, sanctions, or reduced support, which lowers trust and decreases the firm's value.

H_4: Firm Age has a negative effect on Firm Value

Climate Change Disclosure on ROA and Firm Value

The need for climate change disclosure among investors is on the rise, as it can enhance financial performance and trust in the business (Chua et al. 2022; Maji & Kalita 2022). Associated risks, such as disrupted logistics and increased operating costs caused by climate change, threaten corporate profitability and investor confidence, especially in high-emissions sectors such as energy (TCFD 2017; Dye et al. 2021). Investors and lenders expect companies to adapt a low-carbon economy for risk reductions and better profit generations (Wang et al. 2022). Disclosure of climate change information enhances a firm's reputation, competitive edge, and credibility and lowers the cost of capital (Demaria & Rigot 2020). As per stakeholder theory, these efforts satisfy stakeholder expectations and increase firm value (Hirsch 2019). Companies with high carbon emissions often experience a decrease in ROA and Tobin's Q, but climate change disclosure following TCFD recommendations can increase ROA and enterprise value (Gatzert & Reichel 2022).

H_5: CCD moderates the effect of ROA on Firm Value

Climate Change Disclosure on ROE and Firm Value

Climate change risks can reduce revenues due to disruptions in production, supply chains, and material price increases, affecting the financial performance of companies with high climate exposure (TCFD 2017; Berkman et al. 2024). Profitability drives climate project implementation, not emissions intensity or other factors, and strong climate change disclosure enhances company reputation, trust, and capital accessibility (Kouloukoui et al. 2019; Dye et al. 2021). Companies who proactively address climate change are rewarded by the market with higher returns but penalizes carbon-intensive companies with losses, low Q ratio, and low ROE (Chava 2014; Nguyen 2017). Climate change risks and opportunities affect investment returns and firm value (Matsumura et al. 2013). Stakeholder theory supports that disclosing climate change information boosts a company's credibility, reputation, and stakeholders relations, creates a competitive advantage, and meets their expectations.

H_6: CCD moderates the effect of ROE on Firm Value

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Climate Change Disclosure on Firm Size and Firm Value

Large-scale and multinational firms face higher social and political pressures and environmental risks than small and medium-sized corporations and, therefore, disclose more environmental information, including climate change risks (Albertini 2014; Dömötör 2023). The large resources and high-tech expertise of large firms enable them to effectively manage risks, fulfill stakeholder expectations, and comply with TCFD recommendations (Principale & Pizzi 2023). Climate change increases business risks such as logistics disruption, decreased production, and increased costs. Large companies have the potential to innovate, diversify their businesses, and leverage emerging opportunities tied to climate adaptation, such as climate-resilient products and adaptive design (Averchenkova et al. 2016). However, the wrong policies can hinder productive adaptation. Stakeholder theory supports that climate change adaptation and risk disclosure help large companies remain competitive, reduce costs and minimize disruption, thereby meeting stakeholder demands.

H_7: CCD moderates the effect of Firm Size on Firm Value

Climate Change Disclosure on Firm Age and Firm Value

As firms age, they tend to become more rigid, focusing on asset management rather than innovation, reducing growth opportunities and Tobin's Q value (Loderer et al. 2016). Older firms tend to be reluctant to pursue radical green innovations, eventhoughinnovationisimportantfor maintaining business sustainability and achieving sustainability goals (Leyva-de la Hiz & Bolivar-Ramos 2022; Othman & Husssein 2023). However, climate change risks provide new opportunities for companies to secure a competitive edge, which decelerates aging while increasing resilience. Innovative approaches to climate issues, such as energy efficiency, low-emission technologies, and business diversification, are solutions to handle risks and seize opportunities (TCFD 2017). Under stakeholder theory, the disclosure of climate change information can enhance stakeholder appreciation, reduce volatility, and increase firm value (Maji & Kalita 2022; Reber et al. 2021). With mitigation and adaptation actions, companies can increase stakeholder trust, drive innovation and create higher value.

H_8: CCD moderates the effect of Firm Age on Firm Value

Research Framework

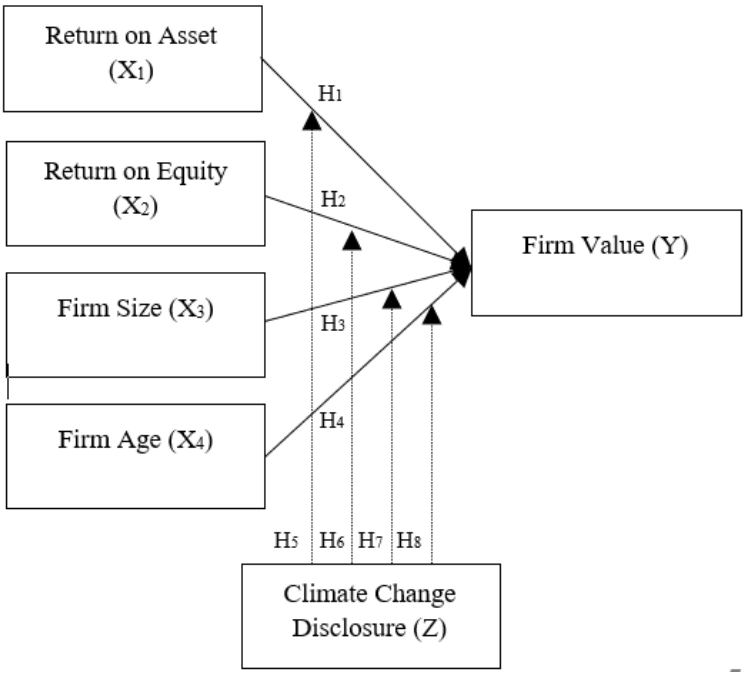

Figure 1. Conceptual Framework

RESEARCH METHODS

This study uses a causal quantitative method, which emphasizes theory testing through research variables to explain the effect of ROA (X_1), ROE (X_2), Firm Size (X_3), and Firm Age (X_4) on Firm Value (Y) with CCD (Z) as a moderator. It sources the secondary data from either the IDX or listed energy sector companies' websites that have published sustainability and annual reports during the 2019-2023 period, utilizing documentation data collection techniques. The data for ROA (X_1), ROE (X_2), Firm Size (X_3), Firm Age (X_4), and Firm Value (Y) are derived from the public annual reports, while Climate Change Disclosure (Z) data is gathered from sustainability reports. A population of 87 energy sector companies were part of this study with 16 companies chosen as a worthy sample through purposive sampling under these criteria: 1) energy sector companies listed on the IDX in 2019-2023; 2) companies that disclosed sustainability reports during the 2019-2023 period; 3) companies that published annual reports during the 2019-2023 period. The majority of energy sector companies use USD as their reporting and functional currencies. Four companies use IDR for their functional and reporting currencies that were translated into USD by using the available exchange rates information found in their notes to financial statements.

Research Samples

Table 2. Purposive Sampling Results

No.	Kriteria Penelitian	Jumlah
1	Energy Sector Companies in 2019-2023	87
2	Companies that do not disclose SR and AR during the 2019-2023 period consecutively	(66)
3	Companies that do not provide data suitable for research during the period 2019-2023	(3)
4	Companies that disclose SR and AR during the 2019-2023 period consecutively	18
5	Companies that have extreme values or outliers during the 2019-2023 period	(2)
6	Number of company samples that meet the research criteria	16
7	Number of years of research	5
	Total of research samples (16 × 5)	**80**

Source : Conducted by Researches (2024)

Operating Variables

ROA

ROA serves as an indicator that gauges the firm's effectiveness in asset utilization productively and efficiently to gain profits. Stakeholders use ROA to analyze the company's potential in generating returns that meet their expectations. A higher ROA figure signifies a greater profitability gained from asset management, which subsequently enhances firm value. The ROA figure is obtained using the following formula (Maji & Kalita 2022):

$$\textbf{\textit{Return on Asset}} = \frac{\textbf{\textit{Net Income}}}{\textbf{\textit{Total Asset}}}$$

ROE

ROE serves as a measure that assesses the range of the firm's efficiency in raising profitability through its equity obtained from the shares invested in the company. An increase in ROE value demonstrates a greater profitability obtained by the company, which leads to higher returns given to shareholders. The figure for ROE can be determined using the following formula (Principale & Pizzi 2023):

$$\textbf{\textit{Return on Equity}} = \frac{\textbf{\textit{Net Income}}}{\textbf{\textit{Total Equity}}}$$

Firm Size

One of the noteworthy assessments for various stakeholders is to evaluate a company based on the number of assets it possesses. Firm size indicates the company's capability to produce large outputs by leveraging its assets resources. The more assets a company possesses, the better its ability to achieve profitability to fulfill its needs and meet stakeholder expectations. The Firm Size is determined through the formula as follows (Kurniawanti & Fitriasari 2024): $\textbf{\textit{Firm Size}} = \textbf{\textit{Ln}}(\textbf{\textit{Total Asset}})$

Firm Age

Firm Age plays an important role for stakeholders when assessing a company's ability to handle a tough and competitive business environment. Companies that are newly established or just entering the market tend to have a high failure rate and less business experience. Conversely, companies with a long-standing presence in the market tend to exhibit low failure rates and established business experience. The Firm Age figure can be determined through the formula as follows (Putri & Bawono 2023):

$$\textbf{\textit{Firm Age}} = \textbf{\textit{Research Year Annual Report Period}} - \textbf{\textit{Established Company Year}}$$

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Firm Value

Firm Value is a key measure that stakeholders use to assess its market standing. In this research, the Q ratio is utilized to analyze the lasting exposure of a business to climate risk. Tobin's Q serves as an effective metric for this purpose and is calculated using the formula as follows (Anggraeni & Fitriasari 2023):

$$\textbf{Tobin's Q} = \frac{(\textbf{MV of Equity} + \textbf{BV of Liabilities})}{\textbf{BV of Total Assets}}$$

Climate Change Disclosure (CCD)

Climate change disclosure following TCFD recommendations is measured using content analysis with binary codes: a score of 1 for disclosed indicators and 0 for undisclosed ones (Iriyadi & Antonio 2021, Park & Kim 2023; Principale & Pizzi 2023; Jastrzębska 2023). Full disclosure yields a total score of 11 points. The formula of CCD is as follows:

$$\textbf{CCD} = \sum \textbf{Disclosed Indicators of TCFD}$$

The TCFD indicators used in this study consist of the following:

Table 3. TCFD Recommendations

Governance	a) Describe the board's oversight of climate-related risks and opportunities.
	b) Describe management's role in assessing and managing climate-related risks and opportunities.
Strategy	a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long-term.
	b) Describe the impact of climate-related risks & opportunities on the organization's businesses, strategy, and financial planning.
	c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2-degree or lower scenario.
Risk Management	a) Describe the organization's processes for identifying and assessing climate-related risks.
	b) Describe the organization's processes for managing climate-related risks.
	c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.
Metrics & Target	a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.
	b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 GHG emissions and the related risks.
	c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.

Source: TCFD (2017)

Data Processing Tools

This study utilized EViews 13 to operate panel data regression and moderated regression analysis, which offers clearer insights into the hypothesis testing outcomes. The study utilizes the following regression models:

Model 1:

$$TQ_{it} = \alpha + \beta_1 ROA_{it} + \beta_2 ROE_{it} + \beta_3 SIZE_{it} + \beta_4 AGE_{it} + u_{it}$$

Model 2:

$$TQ_{it} = \alpha + \beta_1 ROA_{it} + \beta_2 ROE_{it} + \beta_3 SIZE_{it} + \beta_4 AGE_{it} + \beta_5 CCD_{it} + \beta_6 ROA_{it}*CCD_{it} + \beta_7 ROE_{it}*CCD_{it} + \beta_8 SIZE_{it}*CCD_{it} + \beta_9 AGE_{it}*CCD_{it} + u_{it}$$

Where:

α	: Constant
TQ_{it}	: Tobin's Q
ROA_{it}	: Return on Asset
ROE_{it}	: Return on Equity
$SIZE_{it}$	: Firm Size
AGE_{it}	: Firm Age
CCD_{it}	: Climate Change Disclosure
$ROA_{it}*CCD_{it}$	: Interaction between ROA and CCD
$ROE_{it}*CCD_{it}$	: Interaction between ROE and CCD
$SIZE_{it}*CCD_{it}$	: Interaction between SIZE and CCD
$AGE_{it}*CCD_{it}$	: Interaction between AGE and CCD
u_{it}	: Composite Error Term

RESULTS

Descriptive Statistics Analysis

Table 4. Statistic Descriptive Results

	ROA	ROE	SIZE	AGE	TQ	CCD
Mean	0.07	0.09	20.89	32.37	0.96	4.75
Median	0.05	0.10	20.96	28.00	0.92	4.00
Maximum	0.45	0.61	23.10	58.00	1.79	11.00
Minimum	-0.09	-2.54	18.78	12.00	0.49	0.00
Std. Dev.	0.09	0.34	1.37	13.77	0.27	3.45
Observations	80	80	80	80	80	80

Source: Conducted by Researchers (2024)

Three companies fully aligned their climate changeinformationunder TCFDrecommendations, while the other four did not. The highest percentage of disclosure is in the Metrics & Targets indicator (45.79%), followed by Risk Management (22.11%) and Strategy (21.05%), with the lowest Governance (11.05%) out of a total TCFD score of 380. The lowest sub-indicators are the 3rd Strategy (17.50%) and the 3rd Risk Management (20.24%) items.

Panel Data Estimation and Method Selection Tests

Table 5. Chow, Husman, and LM Tests Results

Tests	Probability	Model Chosen
Chow Test	0.0000	FEM
Hausman Test	0.1549	REM
LM Test	0.0000	REM

Source: Conducted by Researchers (2024)

Based on table 5, the Chow Test result reveals the chi-square probability value of 0.0000 below the significance value of 0.05 (0.0000 < 0.05) which suggests that FEM is preferable to the CEM. The Hausman Test result shows the chi-square probability value of 0.1549, exceeding the significance value of 0.05 (0.1549 > 0.05) that suggests REM is better than FEM. The Lagrange Multiplier Test result shows a probability value of 0.0000, which does not exceed the significance value of 0.05 (0.000 < 0.05), suggesting REM holds an advantage over CEM. Hence, the REM regression model is more suitable and efficient than the CEM or FEM regression model, and therefore is selected for use in this study.

Classical Assumption Tests Results
Normality & Autocorrelation Tests

Table 6. Jarque-Bera dan Durbin-Watson Test Results

Tests	Probability
Jarque Bera Test	0.050618
Durbin-Watson Test	1,7716 < 1,794635 < 2,2284

Source: Conducted by Researchers (2024)

Based on table 6, the Jarque-Bera Test result exhibits a probability value of 0.050618, which surpasses the significance level of 0.05 (0.050618 > 0.05). Therefore, the data within the regression model shows normal distribution properties. The Durbin-Watson Test also displays no sign of autocorrelation issues within the panel data regression model, as the DW statistics value of 1,794635 exceeds d_u (1,7716) and less than 4 – d_u (2,2284).

Multicollinearity Test Results

Table 7. Collinearity Diagnostics Results

	X_1	X_2	X_3	X_4	Z
X_1	1.000	0.600	0.053	-0.221	0.108
X_2	0.600	1.000	0.017	-0.165	0.004
X_3	0.053	0.017	1.000	0.293	0.643
X_4	-0.221	-0.165	0.292	1.000	0.403
Z	0.108	0.004	0.643	0.403	1.000

Source: Conducted by Researchers (2024)

Based on table 7, the results reveal the correlation value in each variables ROA (X_1), ROE (X_2), Firm Size (X_3), Firm Age (X_4), and Climate Change Disclosure (Z) are below 0.85 (Widarjono, 2005, 135). Therefore, it is evident that none of the correlation values within the independent and moderating variables exhibit the occurrence of multicollinearity in the panel data regression model.

Heteroscedasticity Test Results

Table 8. Park Test Results

Variable	Prob.	Conclusion
ROA	0.8412 > 0,05	Homoscedastic
ROE	0.5776 > 0,05	Homoscedastic
SIZE	0.0985 > 0,05	Homoscedastic
AGE	0.6111 > 0,05	Homoscedastic
CCD	0.6885 > 0,05	Homoscedastic

Source: Conducted by Researchers (2024)

Based on table 8, the Park Test results show the probability value of ROA (X_1), ROE (X_2), Firm Size (X_3), Firm Age (X_4), and Climate Change Disclosure (Z) variables are greater than 0.05. A Glejser test was previously conducted and revealed that the Firm Size (X_3) did not satisfy the classical assumption of homoscedastic variance. However, REM allows the heteroscedastic variances σ_i^2 to occur in the regression model as shown by the Generalized Least Squares (GLS) approach applied in REM that produces a constant u_i that equals 1, which pertains its homoscedastic variances and its BLUE property (Gujarati, 2004, 394-396). Thus, it suggests that the panel data regression model is not subject to heteroscedasticity.

Panel Data Regression Analysis

Table 9. Regression Models Output

Dependent Variable: TQ									
	Model 1				Model 2				
Variable	Coef.	Std. Error	t	Prob.	Coef.	Std. Error	t	Prob.	Hypothesis
Constant	1.271	0.716	1.774	0.080	0.054	0.844	0.064	0.949	-
ROA	1.505	0.312	4.826	0.000***	5.587	1.306	4.278	0.000***	H_1: Accepted
ROE	-0.146	0.073	-1.998	0.049**	-2.524	0.836	-3.018	0.003***	H_2: Rejected
SIZE	-0.021	0.036	-0.579	0.564	0.040	0.042	0.944	0.348	H_3: Rejected
AGE	0.001	0.004	0.254	0.800	-0.001	0.004	-0.131	0.896	H_4: Rejected
CCD	-	-	-	-	0.146	0.145	1.008	0.317	-
ROA*CCD	-	-	-	-	-0.420	0.146	-2.883	0.005***	H_5: Accepted
ROE*CCD	-	-	-	-	0.242	0.084	2.887	0.005***	H_6: Accepted
SIZE*CCD	-	-	-	-	-0.008	0.007	-1.113	0.270	H_7: Rejected
AGE*CCD	-	-	-	-	0.000	0.000	0.775	0.441	H_8: Rejected
R^2	0.235410				0.351671				
Adjusted R^2	0.194632				0.268315				
F-statistic	5.772945				4.218881				
Prob(F-statistic)	0.000418***				0.000217***				

Notes: α = 5%. *** = significant at 1%, ** = significant at 5%.

As indicated by the regression outputs, the constant value and regression coefficient obtained can be formulated into the panel data regression equation. The equations formed in these regression models are:

$$TQ_{it}=1.270693+1.504980ROA_{it}-0.145952ROE-_{it}-0.020662SIZE_{it}+0.000911AGE_{it}+u_{it}$$

$$TQ_{it} = 0.053711 + 5.586774ROA_{it} - 2.523885ROE_{it}+0.039717SIZE_{it}-0.000572AGE-_{it} + 0.145814CCD_{it} - 0.420179ROA_{it}*CCD_{it} + 0.241801ROE_{it}*CCD_{it} - 0.0076136SIZE_{it}*CCD_{it} + 0.000424AGE_{it}*CCD_{it}+u_{it}$$

Hypothesis Tests

t Test

The t value is obtained in the REM panel data regression results, whereas the t table value is acquired through calculating the degree of freedom (df) using the formula df = n - k - 1 (Widarjono, 2005, 84). With a df value of 74 (80 - 5 - 1), the computed t table value is 1.99254. After obtaining the t value, the t test results in table 9 are detailed as follows:

1. ROA (X_1) has a t value of 4.826209 > 1.99254 with a significance value of 0.0000 < 0.05, so ROA (X_1) has a partial effect on Firm Value (Y).
2. ROE (X_2) has a t value of 1.997955 > 1.99254 with a significance value of 0.0493 < 0.05, thus, ROE (X_2) has a partial effect on Firm Value (Y).
3. Firm Size (X_3) variable has a t value of 0.579342 < 1.99254 with a significance value of 0.5641 > 0.05, therefore, Firm Size (X_3) has no partial effect on Firm Value (Y).

4. Firm Age (X_4) variable has a t value of 0.254517 < 1.99254 with a significance value of 0.7998 > 0.05, hence, Firm Age (X_4) has no partial effect on Firm Value (Y).

Coefficient Determination Test

Model 1's adjusted R^2 is 0.1946, suggesting that ROA (X_1), ROE (X_2), Firm Size (X_3), and Firm Age (X_4) can explain 19.46% of the changes in Firm Value (Y), leaving 80.54% incapable to explain due to other variables outside this research. Model 2 has an adjusted R^2 value of 0.2683, showing a 7.37% improvement due to the addition of the interaction variable CCD (Z). Together, the independent variables, moderator CCD (Z), and its interactions with ROA (X_1Z), ROE (X_2Z), Firm Size (X_3Z), and Firm Age (X_4Z) can explain 26.83% of Firm Value (Y) variations, leaving 73.17% attributed by variables beyond this research.

Moderated Regression Analysis

Based on the model 2 table, the probability values of the interaction variables are interpreted below :

1. Climate Change Disclosure (Z) is able to moderate the effect of ROA (X_1) on Firm Value (Y), with a probability value of 0.0052 < 0.05. The nature of this moderation is weakening since the X_1Z regression coefficient (-0.420179) is lower than the X_1 regression coefficient (5.586774)
2. Climate Change Disclosure (Z) is able to moderate the effect of ROE (X_2) on Firm Value (Y), with a probability value of 0.0052 < 0.05. The nature of this moderation is strengthening since the X_1Z regression coefficient (0,241801) is higher than the X_1 regression coefficient (-2,523885).
3. Climate Change Disclosure (Z) is not able to moderate the effect of Firm Size (X_3) on Firm Value (Y) as the probability value of 0,2696 > 0.05.
4. Climate Change Disclosure (Z) is not able to moderate the effect of Firm Age (X_4) on Firm Value (Y) as the probability value of 0,4408 > 0.05.

DISCUSSIONS

ROA on Firm Value

The t test result displays that ROA (X_1) has a significant positive effect on Firm Value (Y). A high ROA indicates the company's capability to fulfill stakeholder expectations through high profitability and effective and efficient asset management. Good financial performance attracts lenders and shareholders to support business activities through access to new funding, such as equity investments and loans. Investors are generally drawn to companies that efficiently use their assets and maintain high profitability, which can lead to increased stock prices, market value, and Tobin's Q. This study supports the hypothesis H_1 that ROA has a positive effect on firm value, consistent with the findings of previous studies by Putri & Bawono (2023), Yanti et al. (2022), Lambey et al. (2021), Jihadi et al. (2021), Prena & Muliyawan (2020), D'Amato & Falivena (2019), Harningsih et al. (2019), Pradita & Suryono (2019), and Cahya & Riwoe (2018).

ROE on Firm Value

The t test result reveals that ROE (X_2) has a significant negative effect on Firm Value (Y). A high ROE may result from high net income or low equity, which indicates a greater debt-to-equity ratio in some companies. This financial structure increases leverage risks, increases interest payment obligations, heightens shareholder investment risk, and reduces profits available for dividends. In addition, companies with high profitability often face externality impacts that affect stakeholders. Non-financial information such as ESG and CSR becomes crucial for supporting a sustainable economy. However, managers' failure to manage externalities can reduce a company's value through damaged reputation, declining stock price, and other adverse impacts. This study concludes that the hypothesis H_2 that ROE has a positive effect on firm value is rejected, in line with the findings of Abd Latif et al. (2023), Hasanah et al. (2023), and Cahya & Riwoe (2018), which show a negative effect of ROE on firm value.

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Firm Size on Firm Value

The t test result indicates that Firm Size (X_3) has no effect on Firm Value (Y). In the energy sector, the size of total assets does not determine the value of companies. The research shows that although the company's assets fluctuate significantly, the average value of Tobin's Q does not always align with changes in assets. This suggests that the size of a firm's assets does not reflect the effectiveness of managers in managing assets efficiently (Putikadea & Siregar 2023). In addition, increases in assets are often funded through liabilities, which increases leverage risk and reduces shareholder attractiveness. As a result, total asset information does not provide sufficient benefits to stakeholders. This study concludes that the Firm Size hypothesis H_3 has a positive effect on firm value is rejected, consisted with the findings of Novianti et al. (2023), Putikadea & Siregar (2023), Julito & Ticolau (2022), Witjaksono & Sari (2020), Pradita & Suryono (2019), and Putri & Rachmawati (2018) which state that firm size does not affect firm value.

Firm Age on Firm Value

The t test result reveals that Firm Age (X_4) has no effect on Firm Value (Y). The company's length of establishment does not imply a determining factor for the firm's worth because the length of operation does not always reflect high market value, as indicated by Tobin's Q. The data shows that Tobin's Q fluctuates as the company ages. New companies tend to have high growth opportunities through aggressive R&D, but also face a large risk of failure (Coad et al. 2016). In contrast, older firms have high business experience but are less innovative and more focused on asset management (Loderer et al. 2016). Therefore, the length of company's establishment is not always a decisive indicator of firm value. This study concludes that the Firm Age hypothesis H_4 has a negative effect on firm value is rejected, in line with the findings of previous studies such as Novianti et al. (2023), Putri & Bawono (2023), Salsa & Nugraha (2022), Lambey et al. (2021), and D'Amato & Falivena (2019), which state that company age has no effect on firm value.

CCD moderates ROA on Firm Value

The interaction test result shows that Climate Change Disclosure (Z) is able to moderate and weaken the influence between ROA (X_1) on Firm Value (Y). The amount of disclosed information on climate change risks and opportunities by energy sector companies indicates that an increase in ROA may decrease firm value. As the economy shifts to low-carbon, lenders perceive higher risks related to loan repayments, especially as renewable energy projects require large investments with technological uncertainties. Companies with high carbon risk incur higher interest rates because of the cash flow uncertainties (Wang et al. 2022), while the short-term focus by financial actors hinders adequate management of climate change risk (Gunningham 2020). Research shows that companies pay little attention to governance with the lowest score of 11,05% among other indicators, climate resilience strategies and climate risk integration. This lack of information increases stakeholder concerns, reduces ROA, and decreases Tobin's Q. These findings support hypothesis H_5 that suggests climate change disclosure can moderate the effect of ROA on firm value. This conclusion aligns with previous studies by Iriyadi & Antonio (2021), Wang et al. (2022), Chen et al. (2022), and Lee et al. (2015), which show that intensive climate change disclosure can weaken financial performance and reduce firm value.

CCD moderates ROE on Firm Value

The interaction test result displays that Climate Change Disclosure (Z) moderates and strengthens the interaction of ROE (X_2) effect on Firm Value (Y). When listed energy sector companies disclose climate change information that aligns with TCFD recommendations, it canboostprofitability as shown in ROE and firm value indicated in Tobin's Q. These disclosures attract market attention by showcasing proactive measures taken by the company in mitigating climate change threats and leveraging opportunities. This increases shareholder interest, encourages stock purchases, and raises stock prices, thereby strengthening the firm's valuation. This claim is evidenced by Bolton & Kacperczyk (2021) (cited in Berkman et al. 2024), who observed that stocks integrated with significant climate change concerns tend to yield higher returns. When companies disclose climate change information in their operational activities, uncertainty will be reduced, which often leads to a rise in their share price (Hahn et al. 2015) (cited in Achenbach 2021). This study supports the hypothesis H_6 that Climate Change Disclosure moderates the effect of ROE

on firm value. This observation corresponds with past research by Vestrelli et al. (2024), Ghose & Gogoi (2024), Cahyono et al. (2024), Maji & Kalita (2022), Flammer et al. (2021), Dye et al., (2021), and Hirsch (2019), which show that strong climate change disclosures can improve a company's reputation, trust, access to funding, and market value. Additionally, climate change disclosure is also shown to positively affect Tobin's Q (Ghose & Gogoi 2024; Pratama & Wijayanti 2022).

CCD moderates Firm Size on Firm Value

The interaction test result reveals that Climate Change Disclosure (Z) is not able to moderate the influence between Firm Size (X_3) on Firm Value (Y). Despite an increase in climate change disclosure scores during 2019-2023, the fluctuations in Firm Size and Tobin's Q values suggest that climate change information is not affecting firm value. Climate adaptation emerges as a novel concept for large companies, with terms like 'resilience' and 'risk management' often mentioned without relevant actions (Averchenkova et al. 2016). This aligns with the findings, where climate resilience in the 3rd Strategy indicator and climate risk integration in the 3rd Risk Management indicator score the lowest among sub-indicators. The quality of disclosure information often does not reflect a real transition towards climate change adaptation but rather resembles an extension of CSR strategies or even the practice of "greenwashing" (Averchenkova et al. 2016). The newness of the TCFD recommendations leads to inconsistent information across companies, so information from both large and small companies does not add significant value to stakeholders. This result rejects the H_7 hypothesis proposing Climate Change Disclosure moderates the effect of Firm Size on Firm Value, supporting Kouloukoui et al.'s (2019) observation, affirming how climate projects are more related to profitability than firm size. This result contradicts other studies, such as Principale & Pizzi (2023), Dömötör (2023), Maji & Kalita (2022), Chauvey et al. (2015), and Albertini (2014), which suggest that bigger firms typically disclose additional environmental insights and increase firm value.

CCD moderates Firm Age on Firm Value

The interaction test result reveals that Climate Change Disclosure (Z) is not able to moderate the influence between Firm Age (X_4) on Firm Value (Y). This study reveals that the amount of disclosed information concerning climate change does not define the company's establishment to its value. Managers' ability to maintain firm value relies on neither the length of the firm's existence nor the amount of information disclosed. Older firms tend to update their operations for sustainability, but sustainability innovations such as climate change disclosure only prolong existing practices (Hall et al. 2016) (cited in Leoncini et al. 2017). In contrast, new firms face uncertainty due to their visibility and transparency in reflecting the characteristics of the underlying company (D'amato & Falivena 2019). New companies that disclose climate change information cannot provide sufficient information for stakeholders, so they do not add any new value for the stakeholders that will affect firm value. This result contradicts hypothesis H_8 on the moderating effect of CCD between firm age on firm value and does not align with D'Amato & Falivena's (2019) and Leyva-de la Hiz & Bolivar-Ramos's (2022) findings.

CONCLUSION

From the test results and discussion present- ed, the effect of ROA (X_1), ROE (X_2), Firm Size (X_3), and Firm Age (X_4), along with their in- teraction with Climate Change Disclosure (Z) on Firm Value (Y), the conclusions are drawn:

1. ROA (X_1) has a significant positive effect on Firm Value (Y).
2. ROE (X_2) has a significant negative effect on Firm Value (Y).
3. Firm Size (X_3) has no effect on Firm Value (Y).
4. Firm Age (X_4) has no effect on Firm Value (Y).
5. CCD (Z) is able to moderate the effect of ROA (X_1) on Firm Value (Y).
6. CCD (Z) is able to moderate the effect of ROE (X_2) on Firm Value (Y).
7. CCD (Z) is not able to moderate the effect of Firm Size (X_3) on Firm Value (Y).
8. CCD (Z) is not able to moderate the effect of Firm Age (X_4) on Firm Value (Y).

Limitations

A limiting constraint in this study is due to the early implementation of TCFD-aligned climate change disclosure, which remains underdeveloped and leads to inconsistencies. Several companies started implementing them in 2020, while

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others plan to start in future years, such as 2025 or above. Some companies have used TCFD recommendations in the past but later discontinued them. Furthermore, the data collection method related to TCFD standards is still limited to manual content analysis using the search feature.

SUGGESTIONS

The following points summarize the sugges- tions for future research:

1. Future research is recommended to use a more recent year range to explore climate change disclosures, given that the implementation of TCFD recommendations in Indonesia is still new and experiencing inconsistencies. The standard is expected to provide new research opportunities to assess its impact on investment decisions, financial performance, and corporate responses to climate risk.
2. Future research is recommended to integrate new independent, dependent, and moderating variables using IFRS S1 & S2 standards that come into effect on January 1st, 2024. With TCFD now under IFRS, these standards offer more up-to-date indicators, providing opportunities to improve the quality of corporate disclosures.
3. Future research should explore different sectors or sub-sectors, such as forestry, transportation, and the financial sector. A focus on carbon emissions in an evolving economy towards low-carbon, such as carbon pricing and carbon taxes, could offer new insights for companies in supporting sustainability.
4. It is recommended to use text mining with a large language model (LLM), such as "CHATREPORT," to assess the implementation of TCFD recommendations with a score of 0-100 (Ni et al. 2023). This technology simplifies and improves the accuracy of disclosure analysis, thereby improving the quality of research.

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