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Climate change impact on Indonesian firm value: exploring the moderating role of accounting conservatism

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Abstract: Climate change is one of the risks that can occur in countries across the equator, such as Indonesia. Apart from its geographical location, the industrial sector is one of Indonesia's highest contributors to emissions. This research examines the impact of climate change and greenhouse gas (GHG) emissions on firm value, moderated by accounting conservatism. Firm value is measured by Tobin's Q and the market-to-book ratio. The sample consists of high-profile manufacturing industries listed on the Indonesia Stock Exchange in 2020-2021, totalling 208 companies. The results show that climate change, GHG emission issues, and accounting conservatism significantly affect firm value, both directly and moderately. Furthermore, firm value measured using the market-to-book ratio is more sensitive than when measured using Tobin's Q. This study provides a different perspective on sustainability issues and contributes to signalling theory by testing non-financial and financial performance using the same model. To improve sustainability performance, firms and governments should consider the research findings when developing policies and regulations addressing environmental challenges.

Keywords: *Accounting conservatism, Climate change, Firm value, Greenhouse gas, High-profile industry.*

1. Introduction

Geographically, Indonesia is located around the equator and is flanked by two oceans, resulting in the country experiencing three climates: tropical, monsoon, and oceanic. The oceanic climate causes seawater evaporation, affecting air humidity and leading to high rainfall (CNN Indonesia, 2023). Figure 1 shows that the Sea Surface Temperature anomaly in the Indian Ocean indicates a negative Indian Ocean Dipole (IOD) phenomenon, with the temperature of Indonesian waters generally displaying warm sea surface temperatures, where the anomaly value ranges from 0.5 up to 3.0 ^{0}C (BMKG, 2023). However, Indonesia is vulnerable to rising sea levels (World Bank Group, 2021), which can impact the economy through vulnerable infrastructure, including water management facilities, power plants, and transportation networks such as ports and railways (Bloomberg, 2024). Therefore, the issue of climate change has received serious attention from the international community, both in economic and political fields (Zhang et al., 2016).

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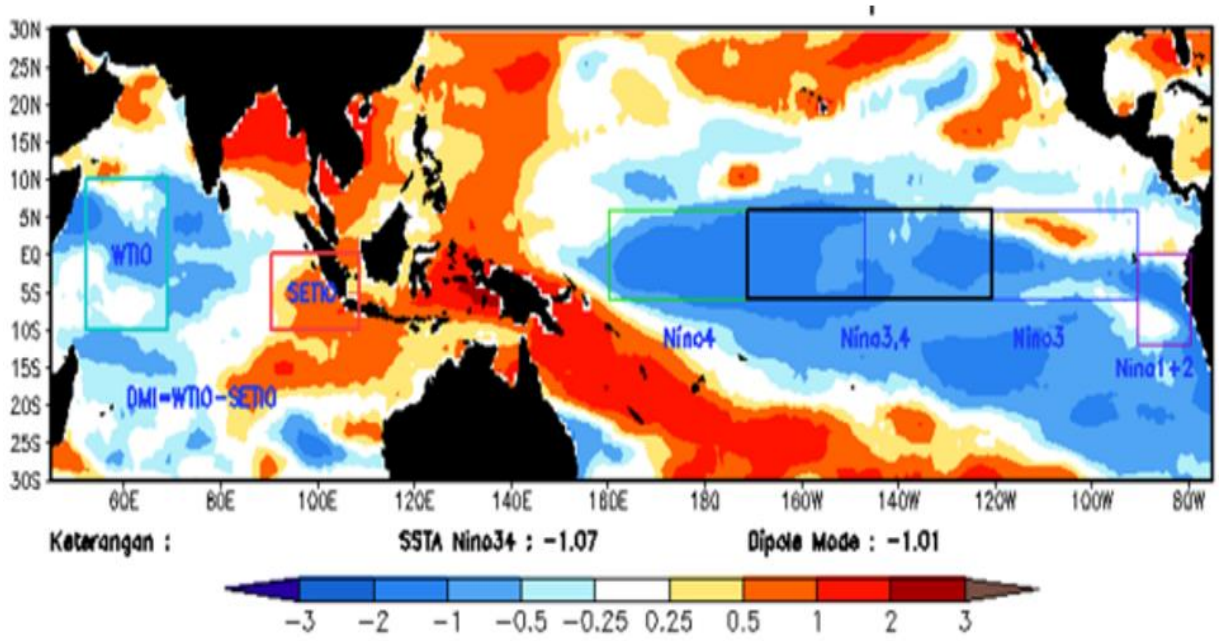

Figure 1.
Basic seabed temperature anomaly.
Source: BMKG (2023)[1]

Environmental issues affect not only economic activity but also the stock market. A classic study tested the market reaction after an oil spill and found significant positive abnormal returns in response to the spill (Patten and Nance, 1998). Unlike Patten and Nance's study, this research analyses the impact of climate change on firm value. Several studies have proven that climate change affects firm value (Park and Noh, 2017; Vestrelli et al., 2024). Moreover, climate change impacts physical risks, which can hamper supply chains, damage facilities, and interrupt business, significantly impacting company finances (Vestrelli et al., 2024). Additionally, shareholders and stakeholders encourage the industry to seriously mitigate the risks of climate change (Toukabri and Youssef, 2022).

The arguments above increase the motivation for this research, which examines climate change on firm performance in Indonesian companies. Firm performance is evaluated based on firm value, measured through Tobin's Q and the market-to-book ratio. Tobin's Q was chosen because it describes market value (Aydoğmuş et al., 2022) and has better statistical test results than Price Book Value (Willim, 2015). Previous research has tested the influence of climate change on firm value in several countries, such as the United States (Berkman et al., 2019; Muhammad Naseer et al., 2023; Ongsakul et al., 2023; Vestrelli et al., 2024), Korea (Park and Noh, 2017), and Spain (Gonzalez and Ramírez, 2016). In contrast to previous research, this research is conducted in Indonesia for several reasons: Indonesia is ranked among the top three countries in terms of climate change levels, climate change threatens Indonesia's food security, and it is estimated to impact disaster risk management, water availability, health and nutrition, and urban development (World Bank Group, 2021).

Even though prior studies have proven that climate change disclosure can influence firm performance (firm value), the interaction of financial report quality, such as accounting conservatism, has not been tested. Accounting conservatism is hypothesised to strengthen the relationship between

[1] BMKG is an abbreviation for the Meteorological, Climatological, and Geophysical Agency. According to the Republic of Indonesia BMKG regulation No. 5 of 2020, this agency is under the authority of, and responsible to, the President of the Republic of Indonesia. The BMKG is responsible for formulating national, general, and technical policies; formulating technical policies; and coordinating policies, planning and programmes in the fields of meteorology, climatology, and geophysics. Additionally, the agency provides data and information services in these fields, among other functions.

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climate change disclosure and firm value through its influence on financial reports and risk management practices. In general, conservatism is the behaviour of accountants who exercise a high level of caution, recognising bad news (e.g., climate change risk) more quickly than good news (Basu, 1997). This can provide stakeholders with an overview of a company's financial health and its ability to adapt to environmental challenges, potentially mitigating the impact of climate change on company value. Moreover, managing climate change requires higher costs, which affect financial reporting, For instance, Pabrik Tjiwi Kimia Paper Tbk's expenses for waste and emission treatment increased significantly from 2019-2021, from $2.340 thousand to $8.854 thousand USD. Similarly, Indah Kiat Pulp and Paper Tbk's costs were $12.580 thousand, $11.666 thousand, and $12.948 thousand USD in the same period. Shaw et al. (2021) demonstrated a positive relationship between sustainability issues, such as corporate social responsibility (CSR), and accounting conservatism. Meanwhile, Khalifa et al. (2023) tested the relationship between climate risk and accounting conservatism, finding a negative impact. Their findings suggest that authorities and standard-setters should mandate the disclosure of climate hazards and integrate such risks into their risk management strategies (Khalifa et al., 2023). Therefore, it is crucial to test accounting conservatism, which has not been tested by prior research, to determine whether it strengthens the relationship between climate change disclosure and firm value.

This research focuses on examining the impact of climate change and accounting conservatism practices on investor responses, as proxied by firm value. This study utilises signalling theory to explain this phenomenon, as opposed to the legitimacy theory applied in Galeone et al. (2023) and Hardiyansah et al. (2021). Besides that, it extends the study of the relationship between climate change and firm value from several previous studies (Naseer et al., 2023; Park and Noh, 2017; Vestrelli et al., 2024).

However, prior studies that explore the potential impact of climate change on firm value have limitations. First, prior research has linked this relationship to non-financial report quality, such as climate attention and climate policy. This research overcomes these limitations by adding accounting conservatism as a moderating factor. Although research by Naseer et al. (2023) includes financial issues such as financial flexibility, this variable does not represent the principle of conservatism. Financial flexibility describes a company's ability to direct its financial situation, while accounting conservatism is a principle that directs how financial information is reported with the principle of prudence. Second, previous studies have primarily focused on developed countries (Naseer et al., 2023; Park and Noh, 2017; Vestrelli et al., 2024). Testing the relationship between climate change and firm value in developing countries is crucial due to differences in geographical, economic, and stakeholder characteristics.

Data for this study was gathered from the manufacturing industries listed on the Indonesian Stock Exchange (IDX), comprising both high and low-profile sectors as identified by previous literature (Newson & Deegan, 2002). Our research focuses exclusively on high-profile industries, justified by their significant carbon emissions, which contribute to climate change and necessitate more extensive carbon disclosure (Ika et al., 2022). Additionally, high-profile industries exhibit greater attention to environmental and social issues compared to their low-profile counterparts (Milne & Hackston, 1996). Therefore, high-profile industries serve as an appropriate model for this study, particularly in Indonesia where they are prevalent across sectors such as chemicals, plastics, pulp and papers, machinery and heavy equipment, food and beverages, and cosmetics. The identification of high-profile companies follows the criteria established by Milne and Hackston (1996) and Newson and Deegan (2002).

While existing literature has established the impact of climate change on firm value (Park and Noh, 2017; Vestrelli et al., 2024), its specific effects on Indonesian firm value and the potential moderating role of accounting conservatism remain unexplored. This study aims to fill this gap by investigating these questions. By doing so, our research makes several contributions to the current literature. First, this research provides new evidence that the quality of financial reports using accounting conservatism strengthens the relationship between climate change and firm value. Secondly, our study presents novel empirical evidence demonstrating the impact of climate change on firm value, specifically in equatorial countries like Indonesia. Thirdly, to our knowledge, this research offers fresh insights into the interplay

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among climate change, accounting conservatism, and firm value, employing data exclusively from high-profile industries.

2. Literature Review

Our literature review focuses on climate change disclosure or similar disclosure and firm value. Table 1 displays a systematic overview of previous research. Table 1 contains four columns consisting of typical literature, research subject, topic and proxy, and main results. The table aims to analyse the position and research gaps of previous research.

Table 1.
Overview of key studies on climate change and firm value.

Typical Literature	Research Subject	Topic and Proxy	Main Result
Current Study	Indonesian companies	Climate change – content analysis (GRI Standards) Accounting conservatism - (Khan and Watts, 2009) Firm value -Tobin's Q	
(Vestrelli et al., 2024)	United States of America	Climate change – Climate attention, climate risk disclosure Firm value – Tobin's Q	There is a positive relationship between climate risk disclosure and firm value.
(Ongsakul et al., 2023)	United States of America	Climate change -the climate policy uncertainty index (Gavriilidis, 2021), climate change exposure Firm value – Tobin's Q	Companies that are more vulnerable to climate change have far lower firm values.
(Naseer et al., 2023)	United States of America	Climate Change – level climate change exposure https://osf.io/fd6jq/files/osfstorage Firm value – Tobin's Q	There is a negative effect between climate change and firm value.
(Park and Noh, 2017)	Korea	Climate change- Levels of greenhouse gas emissions and energy consumption Firm value – Tobin's Q	Climate change has a notable impact on firm value.
(Berkman et al., 2019)	Russell 3000, United States of America Fama-French	Climate change – textual analysis of extracts (CERES Database) Firm value - NA Government commitment- NA	The market anticipates regulatory costs for companies with high climate change risk, which will reduce the company's market value.
(Gonzalez and Ramírez, 2016)	Spanish Companies	Carbon disclosure – Carbon Disclosure Project (CDP) questionnaire	Carbon disclosure is influenced by pressures from markets and shareholders.

According to Table 1, prior research has predominantly focused on developed nations such as the United States, Korea, and Spain. This emphasis is unsurprising given the heightened significance of climate change concerns in North America and Europe (Kim et al., 2010). Consequently, conducting research in developing countries like Indonesia presents an intriguing opportunity. Moreover, there are

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limited studies that measure climate change using GRI Standards. For example, Berkman et al. (2019) used the CERES database, while Gonzalez and Ramírez (2016) used the carbon disclosure project (CDP). In addition, the topics analysed by previous research have not included the accounting conservatism factor, which describes the quality of financial reports. Lastly, the results of previous research still vary regarding the relationship between climate change and firm value. Based on these arguments, this research examines the influence of climate change on firm value, moderated by accounting conservatism, in Indonesian mining and high-profile manufacturing sectors.

2.1. Signalling Theory

Investors' reactions to corporate disclosure can be elucidated through signalling theory, commonly applied at the organisational level to comprehend interactions among parties with varying levels of information, thereby effectively bridging information asymmetries (Bafera and Kleinert, 2022). Signalling theory also provides insight into the impact of climate change disclosure on firm value. While carbon accounting literature often draws from various theoretical frameworks such as legitimacy, institutional, contingency, agency, resource dependence, and stakeholder theories (Hazaea et al., 2023), signalling theory proves particularly apt for this study. The rationale stems from our focus on examining market response, as reflected in firm value, to the climate change performance of high-profile industry companies.

The scope of signalling theory includes the signaller, signal, receiver, and feedback components (Connelly et al., 2011). Connelly et al. (2011) explain that signallers are insiders who have information about organisations that is not yet available to outsiders. Signals represent positive or negative information owned by insiders, and the decision that this information will be distributed to outsiders depends on the insiders' decision. Meanwhile, receivers are outsiders who have little information about the organisation and have an interest in the information held by insiders. Lastly, feedback refers to the response from the receivers to the information sent by signallers. The following presents the relationship between signaller, signal, receiver, and feedback in this research and in previous literature.

Table 2.
Signalling environment.

Author	Signaller	Signal	Receiver	Feedback
Panel A: Signals in the form of environmental or social issues				
(Carrasco and Vílchez, 2022)	Management of company	Corporate Social Responsibility (CSR)	Investors, suppliers, customers, governments	Receiver could demand the practice to be implemented
(Bitektine and Song, 2023)	Management of company	CSR	Individual and family logic, evaluator	Investment decision
(Jung and Song, 2023)	Manager of Company	Climate change	Investors, financial analysts	Investment decision
Panel B: Signals in the form of financial information				
(Houcine, 2017)	Management of company	Financial reporting quality	Investors, capital suppliers	Investment decision
(Alghifari et al., 2022)	Management of company	Strategic corporate financial decision	Investors	Investment decision
Panel C: Signals in the form of environmental or social issues and financial information				
Current study	Management of company	Climate change disclosure, accounting conservatism	Investors, potential investors	Investment decision
(Seth and Mahenthiran, 2022)	Management of company	CSR, Dividend payout policy	Investors	Investment decision
(de Villiers et al., 2023)	Management of company	CSR, Dividends	Investors	Investment decision

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Table 2 presents three main sections: Panel A, which covers research that links environmental disclosure and social issues; Panel B, which links financial information; and Panel C, which links environmental and social issues and financial information. The current study links environmental issues and financial information (accounting conservatism), which serves as a signal and differs from previous research (Alghifari et al., 2022; Bitektine and Song, 2023; de Villiers et al., 2023; Houcine, 2017; Jung and Song, 2023; Carrasco and Vílchez, 2022; Seth and Mahenthiran, 2022) (see Table 1; Panels A, B, and C).

2.2. Climate Change and Firm Value

Energy is one of the most pressing and difficult public policy concerns in the 21st century due to the overexploitation of fossil resources, resulting in environmental destruction and global warming (Fang et al., 2018). Some countries use net-zero initiatives to address the world's urgent climate change issues (Xu et al., 2023). In this study, climate change leads to the disclosure of climate change issues, which are presented in annual reports and corporate sustainability reports. This issue includes direct (Scope 1) GHG emissions, Nitrogen Oxides (NOx), Sulfur Oxides (SOx), and other significant air emissions. More details can be seen in Table 8.

Companies have been compelled to act more responsibly because of the issue of climate change (Ika et al., 2022). Climate change has profoundly impacted businesses' finances and economic development, raising awareness and compelling investors to connect economics and climate risk mitigation (Ahmad et al., 2023). An increasing discussion on how stock markets may aid in the transformation to a low-carbon, climate-resilient economy has been stimulated by the Paris Agreement, which is based on the UN Framework Convention on Climate Change (Bolognesi & Burchi, 2023).

Increased awareness of the difficulties surrounding global climate change draws the attention of outside stakeholders like financial analysts and shareholders, whose surveillance lessens a company's tendency to report unfavourable data (Jung & Song, 2023). The results also support the signalling theory, since the climate change perspective sends a reliable message and draws in investment. Disclosure of climate change issues is expected to increase company transparency towards its activities and prevent legitimacy risks. This is expected to increase the positive reaction from the capital market, thereby increasing firm value. Businesses' economic and financial development has been profoundly impacted by climate change, raising awareness and compelling investors to make the connection between economics and managing climate risk (Ahmad et al., 2023).

This hypothesis is divided into two parts: climate change, which is measured using full disclosure, and the reduction of greenhouse gas (GHG) emissions, which is measured using GRI 305-5 (see Table 8). This division is important considering that GHG emissions are an important issue for the industrial sector. Based on Figure 2, the industrial sector is shown to be the largest GHG contributor. Hence, it is crucial to investigate whether the reduction of greenhouse gas (GHG) emissions impacts investors' investment decisions. Furthermore, to the best of our knowledge, prior research has not extensively explored the effects of GHG emissions reduction. Therefore, this study aims to provide new insights to enhance the scientific contributions in this field. Consequently, we hypothesise:

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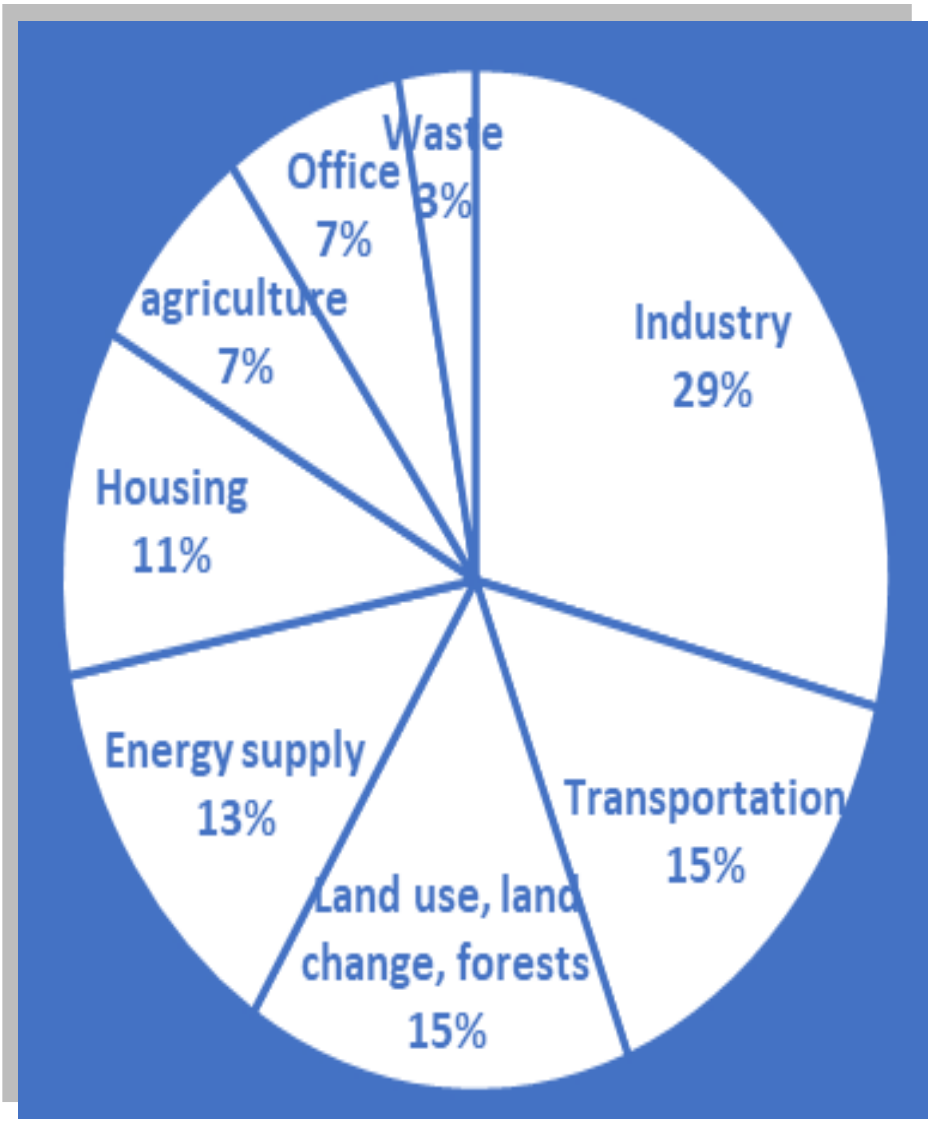

Figure 2.
GHG emissions by sector;
Source: International Energy Agency (IEA)/Johannesburg Renewable Energy Coalition (JREC), 2012, from gapki.id

H_{1a}: Climate change disclosure influences firm value
H_{1b}: Reduction of greenhouse gas (GHG) emissions disclosure influences firm value

2.3. Accounting Conservatism and Firm Value

Financial reports prepared based on the principle of conservatism can be seen as a signal of manager integrity and transparency. Accounting conservatism is defined as a principle that prioritises the recognition of negative news over positive news (Basu, 1997; Ruch & Taylor, 2015). Moreover, this principle can reduce agency costs and information asymmetry, thereby preserving investor confidence (X. Shen et al., 2020). Therefore, accounting conservatism can serve as a positive signal to investors when they are making investment decisions.

Conservative accounting practices can significantly influence users of financial reports in assessing company performance. Ruch & Taylor (2015) review and analyse literature related to accounting

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conservatism and financial statement users. These users are divided into three: equity market users (investors, analysts), debt market users (lenders, borrowers), and corporate governance users (shareholders and management). Their research concludes that conditional conservatism can reduce information asymmetry for equity market users, which, in turn, reduces the accuracy of analysts in making predictions. This aligns with the notion that investors place greater trust in company accounting information under conservative rather than aggressive conditions (Park, 2002). Based on these arguments, it is interesting to examine the influence of accounting conservatism, using measurements from Khan & Watts (2009), on firm value. The reasons for utilising measurements from Khan & Watts (2009) are explained in the methodology section.

H_2: Accounting conservatism influences firm value

2.4. Accounting Conservatism Moderates Climate Change to Firm Value

Climate change can have an impact on the global economy. A report published by the Deloitte Center for Sustainable Progress (DCSP) estimates that if the issue of climate change is left unchecked, it can cost the global economy at least US$ 178 trillion in the next 50 years (Deloitte, 2022). Furthermore, a study conducted by Covington and Thamotheram (2015) analyses the impact of warming on value at risk. The study states that if temperatures rise by 4° or more, global warming may inflict serious economic harm, posing a substantial risk to the value of diversified equity portfolios. This will certainly affect the company's economic turnover. Therefore, it is crucial for companies to actively participate in efforts to prevent climate change.

On the company side, disclosure of climate change requires an appropriate method for reporting and predicting costs incurred for climate change issues. Among the concepts offered by accounting is accounting conservatism. Due to uncertainty about future events, the conservative approach necessitates recognising expenses and liabilities as soon as they are probable (Daryaei et al., 2020). The application of this concept is expected to promote transparency regarding the subject of climate change. Furthermore, conservatism is the company's effort to establish interaction with stakeholders, which is demonstrated by the company's commitment to social responsibility (Boulhaga et al., 2022). Therefore, companies need to implement accounting conservatism in their financial reports to increase the transparency of climate change issues.

Accounting conservatism can play a moderating role in strengthening the relationship between climate change and firm value by recognising the potential risks of climate change. Conservatism supports monitoring and signalling responsibilities, impacting businesses' investment decisions; because profits reflect bad news faster than good news due to asymmetric recognition of gains and losses (Houcine, 2017). Therefore, applying the principle of conservatism will lead to quicker recognition of the risks associated with climate change.

Companies that adopt accounting conservatism and disclose climate change issues are expected to improve the company's reputation to investors. This could affect the firm's value. Based on McKinsey's analysis, among the risks of climate change on business is reputation (Engel et al., 2015). A negative reputation for climate change might harm sales from boycotts by customers or local community rallies (Engel et al., 2015). If this occurs, it will have a negative impact on the company's profitability and investors' decisions to invest. As a result, accounting conservatism can help to enhance the link between climate change disclosures and corporate values.

Accordingly, accounting conservatism can moderate the relationship between climate change and firm value by increasing transparency and enhancing the company's reputation towards its stakeholders. Therefore, the third hypothesis in this study is:

H_{3a}: The relationship between climate change and firm value is strengthened by accounting conservatism.

H_{3b}: The relationship between reduction of GHG emissions and firm value is strengthened by accounting conservatism.

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3. Methodology

3.1. Sample

The data type for this research is panel data, consisting of 104 companies observed over the period from 2020 to 2021. The total research sample consists of 208 data from high-profile manufacturing companies listed on the Indonesia Stock Exchange (IDX). There are several reasons for choosing a sample of this type. First, high-profile industries often face pressure from stakeholders regarding social and environmental issues (Zhong et al., 2022). Second, high-profile industrialised businesses have attempted to mitigate their bad reputations and avoid going to court by being transparent about their carbon emissions to get positive market reactions (Hardiyansah et al., 2021). Therefore, high-profile industries are considered suitable for analysing the relationship between climate change, accounting conservatism, and firm value.

3.2. Variables and Data

Data for the climate change variable is collected by hand from sustainability reports and annual reports. These two reports are analysed using content analysis guided by the GRI Standards 2016 without modification, thus does not require an expert panel to assess the methods used. The content analysis method was carried out by previous research (Deswanto & Siregar, 2018; Fahad & Busru, 2020; Gerged et al., 2021; Helfaya et al., 2023; Newson & Deegan, 2002).

Climate change disclosure in this research is described and measured using the 2016 GRI Standards on the topic of emissions. There are seven issues expressed in Appendix 1. Meanwhile, the reduction of GHG emission was measured using the topic 305-5 only. The measurement is a dummy variable equal to 1 when disclosed and equal to 0 otherwise. Meanwhile, for accounting conservatism and firm value, data were taken from several sources, namely The Indonesia Capital Market Institute (TICMI) database, annual reports, and financial statements. These data sources are used to complement each other's shortcomings. Firm value is measured using Tobin's Q (Gerged et al., 2021; H. Wu & Shen, 2010) and market-to-book (MTB), while accounting conservatism follows the model proposed by Khan & Watts (2009). The selection of Khan & Watts' (2009) model is due to the outcomes aligning with the C_Score metric, which accounts for variations in conservatism. Although many researchers adopt the accounting conservatism model from Basu (1997) (e.g. (Ball et al., 2000; Ball & Shivakumar, 2005; Le et al., 2022), among many others), the model has limitations both in the industry-year measure (using a cross-section of firms) and the individual firm measure (using time series of firm-years) (Khan & Watts, 2009). Therefore, Khan & Watts' (2009) model is chosen to measure accounting conservatism in strengthening the relationship between climate change and firm value.

Below is the model of accounting conservatism presented by Khan & Watts (2009):

$X_i = \beta_1 + \beta_2 D_i + \beta_3 R_i + \beta_4 D_i R_i + e_i$

$G\_Score = \beta_3 = \mu_1 + \mu_1 SIZE_i + \mu_1 M/B_i + \mu_1 Lev_i$

$C\_Score = \beta_3 = \lambda_1 + \lambda_1 SIZE_i + \lambda_1 M/B_i + \lambda_1 Lev_i$

Equations 2 and 3 are substitute equations for eq. 1, so they are not regression model equations. G_Score and C_Score describe company characteristics (company size (SIZE), market-to-book (M/B), and leverage (Lev)). Meanwhile, the explanation of equation 1 code is as follows: X is earnings, R is returns, D is a dummy variable (1 when return < 0 and 0 otherwise), i indexes the firm, and e is residual.

The hypothesis was tested using several main and supplementary tests, namely Ordinary Least Square (OLS), Fixed Effect Model (FEM), and Random Effect Model (REM). Apart from that, a supplementary test was carried out using two-stage least squares (2SLS). The results of this test are presented in the next section.

The regression model is as follows: model of environmental disclosure, corporate governance, accounting conservatism, and firm value.

$FV = \beta_0 + \beta_1 CLMT + \beta_2 GHG + \beta_3 ACCV + \beta_4 (CLMT*ACCV) + \beta_5 (GHG*ACCV) + \beta_6 AGE + \beta_7 ROA$ (Panel A)

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$MTB = \beta_{0+} \beta_1 CLMT + \beta_2 GHG + \beta_3 ACCV + \beta_4 (CLMT*ACCV) + \beta_5 (GHG*ACCV) + \beta_6 AGE + \beta_7 ROA$ (Panel B)

Where;
FV : Firm Value
MTB : Market-to-Book
CLMT : Climate Change Disclosure
GHG : Reduction of GHG emissions
ACCV : Accounting Conservatism
AGE : Firm Age
ROA : Return on Assets

4. Finding and Discussion

4.1. Descriptive Statistic

Table 3 shows the mean, standard error of the mean, median, standard deviation, minimum, and maximum of the model, including the control variables: AGE and ROA. The total data in this study is 208 consisting of data from 2020 and 2021.

Table 3 presents the company's financial performance variables: accounting conservatism (ACCV) and ROA. The maximum (minimum) values of ACCM and ROA are 2.803 (-26.007) and 0.599 (-0.214). Meanwhile, the company's market performance is described by the market-to-book (MTB) and Tobin's Q (FV) with maximum (minimum) values of 56,792 (0.107) and 0.51 (1.729). There is quite a distance between the minimum and maximum values of the data. This can affect abnormally distributed data. The original data shows a high value of the company's kurtosis for some variables, indicating non-normal distributions. To reduce the possibility of outlier effects, the data was Winsorized (Lee et al., 2021), a technique also employed by several other researchers (Bao et al., 2023; Khanchel et al., 2023; Shankar Shaw et al., 2021; Shen & Ruan, 2022; Xu et al., 2022). Despite Winsorization, the data remains non- normally distributed (Mohammed, 2011). However, Hair et al. (2010) argue that the adverse consequences of non-normality diminish with increasing sample sizes (i.e., 200 or more), where significant departures from normality may become insignificant.

Table 3.
Descriptive statistics.

		MTB	FV	CLMT	GHG	ACCV	CLMT_ACCV	GHG_ACCV	AGE	ROA
N	Valid	208	208	208	208	208	208	208	208	208
	Missing	0	0	0	0	0	0	0	0	0
Mean		2.822	1.388	0.170	0.158	-3.453	-0.792	-0.780	38.982	.045
Std. error of mean		0.3783	0.119	0.0159	.0253	.230	0.107	0.145	1.288	.006
Median		1.432	0.716	0.000	0.000	-3.258	0.000	0.000	38.965	.034
Std. deviation		5.456	1.729	0.230	0.366	3.323	1.548	2.094	18.586	.0921
Minimum		0.107	0.051	0.000	0.000	-26.007	-9.707	-9.077	6.926	-.214
Maximum		56.792	13.655	1.000	1.000	2.803	0.879	0.460	116.647	.599

MTB Market-to-book **FV** Firm Value **CLMT** Climate Change **GHG** Reduction Greenhouses Gas (GHG) Emission **ACCV** Accounting Conservatism **CLMT_ACCV** Climate Change Moderated by Accounting Conservatism **GHG_ACCV** Reduction GHG Emissions Moderated by Accounting Conservatism **AGE** Firm Age **ROA** Return on Asset

Table 3 reveals a correlation matrix of all variables, including AGE and ROA as control variables. All variables do not have a relationship that is too high and are free from multicollinearity issues.

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Table 4.
Correlation matrix.

	FV	CLMT	GHG	ACCV	CLMT_ACCV	GHG_ACCV	AGE	ROA
FV	1							
CLMT	0.129	1						
GHG	0.065	0.666	1					
ACCV	-0.668	-0.268	-0.192	1				
CLMT_ACCV	-0.466	-0.747	-0.528	0.648	1			
GHG_ACCV	-0.160	-0.604	-0.860	0.329	0.670	1		
AGE	0.133	0.258	0.18	-0.313	-0.276	-0.133	1	
ROA	0.402	0.212	0.163	-0.526	-0.414	-0.229	-0.25	1

4.2. Static Panel Data and Discussions

Table 5 presents the results of statistical analysis of two models: Panel A and Panel B. The two models were subjected to the same statistical tests, starting with POLS, REM, and FEM. Next, to determine the optimal test, a Breusch and Pagan Lagrangian Multiplier (BP-LM test) and the Haustman tests were conducted. Based on Table 5, both Panel A and Panel B indicate preference for the REM test.

The next tests are multicollinearity, heteroskedasticity, and autocorrelation tests. The results show that both panels have heteroskedasticity and autocorrelation issues. As a result, the REM test results cannot be used as a guide to prove the hypothesis. To address this issue, we employed the Generalised Least Squares (GLS) technique (Akrout & Othman, 2016; Bui et al., 2023; Haddad & Ammari, 2021). Based on the results of the GLS test, all independent variables have a significant effect on firm value except for the GHG variable in Panel A. Furthermore, several variables have an effect below the <0.01 level (Panel A are ACCV, CLMT_ACCV; Panel B are CLMT, GHG, ACCV, CLMT_ACCV, and GHG_ACCV).

Table 5.
Static panel data analysis.

	POLS		REM		FEM		GLS	
	Panel A	**Panel B**	**Panel A**	**Panel B**	**Panel A**	**Panel B**	**Panel A**	**Panel B**
Constant	0.001***	0.276	0.478	0.101	0.960	0.338	0.001***	0.265
	(0.73)	(0.727)	(0.217)	(-1.569)	(0.132)	(-6.694)	(0.73)	(0.727)
CLMT	0.018**	0.000***	0.788	0.805	0.981	0.466	0.015**	0.000***
	(-1.812)	(-10.12)	(0.110)	(0.295)	(-0.103)	(0.832)	(-1.813)	(-10.119)
GHG	0.230	0.001***	0.787	0.841	0.546	0.178	0.219	0.001***
	(0.683)	(5.582)	(-0.073)	(-0.157)	(-0.158)	(-0.935)	(0.683)	(5.583)
ACCV	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(-0.27)	(-0.697)	(-0.532)	(-1.644)	(-0.68)	(-2.037)	(-0.270)	(-0.697)
CLMT_ACCV	0.001***	0.000***	0.624	(0.407	0.892	0.108	0.001***	0.000***
	(-0.455)	(-2.665)	(0.045)	(0.226)	(-0.013)	(0.415)	(-0.455)	(-2.665)
GHG_ACCV	0.033**	0.000***	0.946	0.845	0.932	0.213	0.029**	0.000***
	(0.22)	(1.78)	(0.004)	(0.034)	(-0.005)	(-0.198)	(0.220)	(1.779)
AGE	0.111	0.815	0.026**	0.241	0.690	0.699	0.102	0.811
	(-0.008)	(-0.004)	(-0.016)	(-0.026)	(-0.027)	(0.07)	(-0.008)	(-0.004)
ROA	0.242	0.730	0.802	0.435	0.633	0.486	0.231	0.725
	(1.322)	(-1.168)	(-0.176)	(-1.589)	(-0.329)	(-1.271)	(1.322)	(-1.168)
Observation	208		208		208		208	
Breush and Pagan Lagrangian Test	Chibar2: Panel A (8.31) and Panel B (44.06)							
	Prob > chibar2: Panel A (0.002) and Panel B (0.000)							

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	POLS		REM		FEM		GLS	
	Panel A	**Panel B**	**Panel A**	**Panel B**	**Panel A**	**Panel B**	**Panel A**	**Panel B**
Hausman Test			Panel A (-32.18) and Panel B (7.83)					
			Panel A: The model does not satisfy the Hausman test's asymptotic assumptions Panel B: 0.3474 > 0,05					
Multicollinearity Test			Panel A (3.85) and Panel B (3.85)					
Modified Wald Test			Prob>chi2: Panel A (0.0000) and Panel B (0.000)					
Breush-Godfrey LM Test			Prob>chi2: Panel A (0.0000) and Panel B (0.0000)					
	t statistics in brackets *** p < 0,01 and **p<0,05							

Note: *Refer to Table 3 for the denotation of variables

In Table 5, we investigate the impact of climate change disclosure on firm value using two models: Tobin's Q and market-to-book. In addition, greenhouse gases (GHG) are derived from the GRI emission disclosure 2016 and serve as a variable predicting firm value in this research, consistent with previous studies (Gregory, 2022). The research tested two models coded as Panel A and Panel B. Based on the results of statistical tests, all hypotheses were accepted for both panels except for GHG in Panel A (Hypothesis 1b).

Table 5 shows that climate change has a significant effect on firm value with a significance level below 1% (see Panel B). The coefficient shows a negative direction, namely -1.812 (Panel A) and -10.12 (Panel B). Because this research uses a two-tailed test, hypothesis 1a is accepted. This result is in line with Naseer et al. (2023), which proves that climate change risk has a negative effect on firm value. Businesses are facing more and more environmental issues, and this can have a negative impact on their total value and financial performance due to their exposure to risks related to climate change (Naseer et al., 2023). In line with Naseer et al. (2023), Gregory (2022) argues that the amount of greenhouse gases in the atmosphere will have a detrimental impact on firms' value. The essence of these results indicates that investors tend to assess the company's emissions disclosures negatively. This investor behaviour is thought to be caused by the risk of high costs associated with climate change disclosure, especially for large companies. This is supported by the high correlation between climate change and firm size with a significance level of 0.01 (refer to Table 6). Therefore, investors tend to prefer companies that are committed to reducing GHG emissions. This is in line with the results of the statistical test for hypothesis 1b in Panel B, which proves that reducing GHG emissions significantly affects firm value, with significance at the 0.01 level. Negative risk and unpredictability arise when GHG emission targets are not met (Guastella et al., 2022).

Table 6.
Correlation of climate change and firm size.

		CLMT	**SIZE**
CLMT	Pearson correlation	1	0.278**
	Sig. (2-tailed)		<0,001
	N	208	208
SIZE	Pearson correlation	0.278**	1
	Sig. (2-tailed)	<0.001	
	N	208	208

Note: **. Correlation is significant at the 0.01 level (2-tailed).

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Furthermore, accounting conservatism is essential in influencing firm value in this research. Accounting conservatism significantly influences firm value at the 0.01 level, which is tested with five different methods: POLS, FEM, REM, GLS, and 2SLS, all yielding consistent results. The results illustrate that the practice of conservatism in companies is closely related to market performance. Returns and pricing are related to accounting conservatism factors (contracting, litigation, and regulation) at various levels (Petruska & Wakil, 2013). Statistics show that the coefficient is negative, meaning that investors are likely to be careful when investing in companies that practice accounting conservatism. When compared to neutral or aggressive accounting techniques, the most obvious consequence of conservative accounting practices is the underreporting of net assets and cumulative net income (X. Shen et al., 2020). Therefore, the principle of conservatism makes company profits look lower in the reporting year. This condition can change investors' investment decisions in the company.

The practice of conservatism does not always receive a negative response from investors. When accounting conservatism practices are connected to environmental issues (i.e. climate change, greenhouse gas emissions), investors respond positively. Statistics show that climate change and GHG reduction disclosures significantly influence firm value with a positive coefficient in both Panel A and Panel B. These results support Wu et al. (2022), which argues that accounting conservatism has long been demonstrated as a useful tactic for lowering perceived, financial, and operational risks. Furthermore, polluted air affects conservative accounting practices through the mechanism of risk perception rather than altering a firm's performance (Wu et al., 2022). In summary, accounting conservatism improves the relationship between climate change, reduction of GHG disclosure, and firm value.

4.3. Supplementary Test

Supplementary tests, using 2SLS (Elmarzouky et al., 2023; J. Xu et al., 2023), were carried out to resolve endogeneity (Elmarzouky et al., 2023). The results are consistent with previous findings. All independent variables have a significant effect on firm value, except for GHG in Panel A. Apart from that, the consistent results prove that accounting conservatism has a significant effect at levels below 0.01, and climate change has a negative effect on firm value.

Table 7.
Additional test.

	2SLS	
	Panel A	**Panel B**
Constant	0.001***	0.268
	(0.729)	(0.739)
CLMT	0.017**	0.001***
	(-1.823)	(-10.252)
GHG	0.226	0.001***
	(0.689)	(5.650)
ACCV	0.001***	0.001***
	(-0.270)	(-0.695)
CLMT_ACCV	0.001***	0.001***
	(-0.457)	(-2.684)

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	2SLS	
	Panel A	**Panel B**
GHG_ACCV	0.033**	0.001***
	(0.221)	(1.786)
AGE	0.111	0.813
	(0.008)	(-0.004)
ROA	0.243	0.723
	(-0.008)	(-1.202)
Observation	208	208

Note: *Refer to Table 3 for the denotation of variables.

5. Conclusion

This research examines the variables of climate change disclosure, reduction of GHG, and accounting responsiveness to firm value. There are two main models: Panel A, where firm value is measured using Tobin's Q, and Panel B, where firm value is measured using market-to-book. Even though the hypothesis consists of Panel A and Panel B, they are combined into hypotheses 1A and 1B due to the close relationship between climate change and GHG issues (see methodology chapter and details in Appendix 1).

Thus, this study tests and analyses the main hypotheses. First, climate change emissions disclosure influences the firm value with a negative coefficient. These results confirm the studies of Berkman et al. (2019), Muhammad Naseer et al. (2023), Ongsakul et al. (2023), and J. Hwan Park & Noh (2017). The results prove that investors are likely to assess the risk of climate change accompanied by formal reporting which can burden the company's environmental costs and affect its financial performance. Meanwhile, the results of hypothesis 1b, namely the reduction of GHG emissions, have a positive effect on firm value. Reducing GHG emissions signals to investors that a company is committed to improving its sustainability performance, suggesting that its prospects are better than those of competitors in the era of sustainability. Therefore, investors are predicted to prefer companies that are committed to sustainable performance.

Second, accounting conservatism influences firm value at the 0.01 level with a negative coefficient. The application of the concept of conservatism makes the company's profits in the reporting year appear smaller. This condition makes investors cautious when investing in the company. These results contribute to the literature on accounting conservatism and firm value and build on the findings of Park & Chen (2006).

Third, accounting conservatism strengthens the relationship between climate change and the reduction of GHG disclosure on firm value. These results strengthen the study of Wu et al. (2022). Accounting conservatism is predicted to be a concept that can minimise environmental and financial risks in the future by recognising these risks early. This condition allows investors to prefer the mitigation techniques used by the company.

Our research has several implications. First, the Indonesian government may implement regulations on climate change to reduce the impact of company operations on the environment and society. Second, the practice of accounting conservatism should be a focus of companies and accounting standard setters in Indonesia, as it is expected to encourage transparency and relevance in financial accounting.

This research has several limitations. First, the sample only uses high-profile manufacturers in 2020-2021. Future research could add other high-profile companies, such as the mining industry, and increase the sample period. Second, sustainability issues are currently limited to emissions and the

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reduction of GHG emissions, guided by the GRI Standard 2016. Future studies could include the reduction of energy and the use of other standards from regulators, NGOs, as well as additional research findings.

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Appendix 1

Table 8.
GRI 2016 (305-emission).

Code	Topic disclosure	Requirements
305-1	Direct (Scope 1) GHG emissions	Gross direct (Scope 1) GHG emissions include the gases involved in the calculation, biogenic CO2 emissions, the base year for calculation, source of emission factors, consolidation approach for emissions, standards, assumptions, methodologies, and/or calculation tools used.
305-2	Energy indirect (Scope 2) GHG emissions	Gross location-based indirect (Scope 2) GHG emissions include the gases involved in the calculation, the base year for calculation, source of emission factors, consolidation approach for emissions, standards, assumptions, methodologies, and/or calculation tools used, if available.
305-3	Other indirect (Scope 3) GHG emissions	Gross other indirect (Scope 2) GHG emissions include the gases involved in the calculation, biogenic CO2 emissions, other indirect (Scope 3) GHG emissions categories and activities included in the calculation, source of emission factors, consolidation approach for emissions, standards, assumptions, methodologies, and/or calculation tools used, if available.
305-4	GHG emissions intensity	GHG emissions intensity ratio for the organisation, the organisation-specific metric (the denominator) chosen to calculate the ratio, types of GHG emissions included in the intensity ratio, and the gases included in the calculation.
305-5	Reduction of GHG emissions	GHG emissions reduced as a direct result of reduction initiatives include the gases involved in the calculation, the base year or baseline, scopes in which reductions took place, standards, assumptions, methodologies, and/or calculation tools used.
305-6	Emissions of ozone-depleting	Production, imports, and exports of ODS include the substances involved in the calculation, source of the emission factors used,

Code	Topic disclosure	Requirements
	substances (ODS)	standards, assumptions, methodologies, and/or calculation tools used.
305-7	Nitrogen Oxides (NOx), sulfur oxides (SOx), and other significant Air emissions	Significant air emissions include the source of the emission factors used, standards, assumptions, methodologies, and/or calculation tools used.

Source: ((GRI-GSSB), 2016).

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