

The Impact of GHG Emission Performance on Financial Performance: Moderating by Financial Constraints and COVID-19

Meliani Nababan*, Sylvia Veronica Nalurita Purnama Siregar

Faculty of Economics and Business, Universitas Indonesia, Jakarta, Indonesia

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*Corresponding author: melianinababan@gmail.com

Abstract: Previous studies on the impact between GHG emissions and financial performance presented two competing points of view: either reducing GHG emissions can cause firms to diverge from their corporate goals, or, reducing GHG emissions can raise firm value in line with the resource-based view theory. This study examines 105 non-financial industry in Indonesia that produce significant amounts of emissions GHG between 2019 and 2021, with a total of 315 data observations. This study analyzes the financial performance using ROA and firm value, and the performance using two constructs: the quantity of emissions and disclosure of GHG emissions. The Global Initiative Report (GRI) guidelines are used to conduct content analysis on disclosure of GHG emission. This study shows that GHG emission performance is considered as a firm's competitive advantage, there is a positive impact between GHG emission performance and firm value, financial constraints negatively affect the impact between GHG emission performance, and COVID-19 had no effect on the impact between emission performance and financial performance.

Keywords: emission performance, profitability, firm value

1. Introduction

Palmer, Oates, & Portney (1995) research found action to reduce emissions of GHG does not impact their financial performance. A firm engages in environmental activities misallocates firm resources, incurs additional costs, and lowers the firm's value. Gray et al. (1998) also show that environmental regulation can reduce a firm's ability to invest in productive assets and reduce the firm's competitiveness. These studies are contrary to the theoretical underpinning of the current sustainable issues that carbon emission reduction activities increase sustainable competitive advantage and supports institutional theory that firms are rewarded by stock market for having low carbon emission levels and complying to carbon regulations (Benkraiem, Shuwaikh, Lakhal, & Guizani, 2022; Clarkson, Li, & Richardson, 2004).

Global economic expansion has led to a rise in energy consumption, which is dominated by fossil fuels, the primary source of GHG emissions that contribute to the rise in global temperatures. In addition to harming the environment and raising the risk of natural disasters, climate change also has a cascading effect on society and the economy. Climate change negatively impacts a nation's overall Gross Domestic Product (GDP) and most macro- and microeconomic factors (Abeysekara, Siriwardana, & Meng, 2023). Indonesia continues to its

effort to reduce carbon emissions by issuing guidelines and implementing variety of regulations, the Presidential Regulation of the Republic of Indonesia Number 71 of 2011, Indonesia Green Taxonomy for environmental-based financing policies, the Corporate Performance Rating Program called PROPER from the Ministry of Environment and Forestry, Sustainable Development Goals issued by Bappenas, and Financial Services Authority Regulation No 51/POJK.03/2017. A carbon tax policy is being drafted in Indonesia and is expected to be implemented in 2025. Firms who produce GHG emissions above a practical threshold are subject to this tax law. GHG emission regulations encourage companies to invest in reducing GHG emissions. Regulations related to climate change have an impact on corporate investment because firms are required to invest more in the environment (Porter & Van Der Linde, 1995).

Firms can indirectly reduce carbon dioxide emissions by investing in renewable energy sources or non-fossil energy sources, such as wind energy (Yang, Zhang, Liu, & Zhou, 2022). The findings of a study by Hailemariam, Ivanovski, & Dzhumashev (2022) show that R&D and investment in renewable technology have a considerable positive impact on environmental quality by lowering various pollutants, such as carbon dioxide and methane. The company must undertake bargains to reduce GHG emissions, such as spending money on clean energy, replacing production equipment, paying for R&D, and managing GHG emission costs. Since environmental investments and capital investments are typically made in the same year, firms will divert investment away from productive assets and invest in reducing emissions for improving GHG emission performance (Gray et al., 1998).

The impact between emission performance and financial performance may be influenced by the company's financial condition. Firms need resources to run their business, including financial resources to carry out firm strategies and projects, some resources come from within the firm, and others are controlled by other entities, firms rely on resources from other parties, through the debt market or equity market as a firm resource to carry out projects that generate profits (Margaritis & Psillaki, 2010). The firm's inability to access the necessary financial resources is called a financial constraint, they have limited resources in funding profitable investments. Rahman's (2023) research shows that product innovations that are environmentally friendly have an impact on financial constraints, firm that has concern for GHG emission performance makes firms have a better bargaining position to negotiate with financial institutions like banks, firms with good GHG emission performance can have easier financial access, making them less financially restricted, it is supported by the rapid growth of green finance practices, which have changed the financing pattern of the global financial industry (Shahbaz et al., 2023).

This research was conducted in the range of years affected by COVID-19. The early period of COVID-19 has caused a cessation of economic activity thereby increasing enormous uncertainty for firms, the COVID-19 pandemic crisis has made financial performance worse, especially firms that are established in countries with low healthcare systems (Hu & Zhang, 2021). Guérin & Suntheim (2021) analyze the relationship between COVID-19 and corporate GHG emission performance, where COVID-19 had resulted in a cessation of economic activity, impacting the reduction in production, and decreasing in the number of emissions. COVID-19 may have an effect on the impact between GHG emission performance and financial performance because it led to strong GHG emission performance due to lower emissions, but COVID-19 decreased the financial performance.

This research contributes to the understanding of the impact between emissions GHG performance and financial performance (Benkraiem et al., 2022; Choi & Luo, 2021; Dang, Wang, & Wang, 2022; Gallego-Álvarez, Segura, & Martínez-Ferrero, 2015; Matsumura, Prakash, & Vera-Muñoz, 2014; Saka & Oshika, 2014; Trinks, Mulder, & Scholtens, 2020),

previous studies regarding the impact between carbon emissions performance and financial performance have not drawn any conclusions. This research evaluating four constructs of the relevant indicator of GHG emissions performance—total emissions, emission intensity, disclosure of GHG emissions, and environmental management costs—tested using PLS SEM, and shedding insight on how COVID-19 and financial constraints affect the impact between financial performance and GHG emission performance. The research helps firms and the government in understanding how efforts to reduce greenhouse gas emissions have an influence on profitability and firm value because when firms invest in reducing GHG emissions, firms face concerns about declining firm profitability, so companies need advice on reactive or proactive strategies to respond to emission regulations and the government also interested in learning how carbon regulations affect corporate social responsiveness, profitability, and welfare because the conventional view of the government is enforcing carbon regulations to reduce emissions will encourage the application of green technology and improve social welfare (Fu, Li, Mao, & Miao, 2023).

2. Literature Review

2.1. GHG Emission Performance

GHG emission performance is the company's efforts to reduce GHG emissions. The skeptical point of view is that companies respond to environmental compliance as a challenge that creates further costs and financial difficulties that reduce company profits and reduce company value (Benkraiem et al, 2022). In this study, emission performance is measured by the number of emissions, emission intensity, disclosure of emissions in annual reports and sustainability reports, and environmental costs.

2.2. Firm Value

The perception of investors about a company managing its resources to produce the greatest possible profits for the company is known as firm value. The market value of the company's shares serves as a good indicator of the company's worth (Benkraiem, 2022). Stock prices are influenced by a variety of factors, including non-financial information that may alter investors' opinions and financial information that is reflected in financial reports.

2.3. Return on Assets (ROA)

Return on Assets (ROA) ratios are used to find out how the company's capability in obtaining profits from the company's business processes is related to assets that generate income. Company productivity and income are related to company assets, as well as company GHG emission residues depending on the use of company assets. ROA shows how a company can generate profits as if the company reduces GHG emissions. ROA financial ratios can also identify the efficiency effect of GHG emissions on short-term accounting profit (Rinksa, Muldera, & Scholtens; 2020).

2.4. Financial Constraints

This research measure financial constraint using KZ index formulated by Kaplan & Zingales (1997), the greater the value of the KZ index, the greater the company's financial constraints. The condition where the firm does not have the ability to access funding from external sources called financial constraint. Firms that are generally financially constrained will also be constrained in carrying out daily business activities because the existence of financial

constraints has a negative effect on the overall economic condition of the firm (Cherchye et al., 2020).

2.5. Hypothesis

2.5.1. Effect of GHG Emission Performance on Environmental Performance

Carbon efficiency have positive impact with profitability (Trinks et al., 2020) because there are additional costs that firms need to pay when firms emit carbon below a reasonable threshold. The regulation of carbon pricing turns carbon emissions into costs that are internalized to firms, implying that profitability per unit of output will increase as marginal returns decrease (Dam & Scholtens, 2015). In contrast to developed countries, Indonesia has not implemented regulations regarding carbon pricing or carbon taxes, the increasing carbon emission does not reduce firms' profits.

The firm's sales revenue depends on productive assets investment in the past, increased production, which increase in the amount of emissions (Dang et al., 2022). Compliance with emission regulations makes companies pay for environmental cost and it will reduce company profits. So, the research hypothesis regarding the impact between the GHG emission performance and Return on Assets (ROA) is:

***Hypothesis 1a:** GHG emission performance has a negative impact on ROA.*

Barney's (1993) theory that states firms have several unique resources, competencies, and capabilities (heterogeneity). The resources have value, are difficult to find (rarity), difficult to duplicate (imitability), and difficult to replace (substitutability). Hart (1995) & Gallego-Álvarez et al. (2015) support the theory of the resource-based view and found that firms gain a competitive advantage by increasing the firm efforts to contribute to controlling climate change. Positive reactions from society and the market to corporate environmental and ethical practices lead to sustainable competitive advantages over time, and investors also perceive the compliance and ability to reduce GHG emissions as a competitive advantage. Along with the perspective of institutional theory, firms that face institutional pressure such as GHG emission regulation will eventually adopt practices to achieve legitimacy that increases the competitiveness and performance of the firm. So, the research hypothesis regarding the impact the GHG emission performance on firm value is:

***Hypothesis 1b:** GHG emission performance has a positive impact on firm value.*

2.5.2. The Effect of Financial Constraints on the Relationship Between GHG Emission Performance and Environmental Performance

Firms that experience difficulties accessing external finance are often unable to fulfill their growth ambitions in terms of investment. Indonesia has a regulation regarding green financing, the Indonesia Green Taxonomy, where GHG emission performance is an indicator of funding considerations. Emissions performance provides a bargaining position for financial institutions such as banks; GHG emission performance is a value added for firms to gain access to corporate funding (Zhang & Jin, 2021). Emission performance encourages firms to have easier access to funding, and when a firm is not financially constrained, it obtains capital to improve its productivity by investing in productive assets that enable firms to increase their profitability (Rahman, 2023). So, the research hypothesis regarding the impact the GHG emission performance on firm value moderating by financial constraint is:

***Hypothesis 2a:** KZ Index has a negative effect on the impact of emissions GHG performance on ROA.*

Stock portfolio with good GHG emission performance firms perform better in equity market than portfolios with environmentally unconcerned firms because investors find abnormal earnings in stock portfolios with companies that have good emission performance (Cortez, Andrade, & Silva, 2022). Good GHG emission performance firms can have easier access to finance, thereby making them less financially restricted, when the company is not financially restricted, this is a positive signal for investors to invest because the company can carry out productive performance because they get enough for financing a new assets or new project (Rahman, 2023). Financial constraints affect the impact GHG emission performance on firms value with the following hypotheses:

***Hypothesis 2b:** KZ Index has a negative effect on the impact of emissions GHG performance on firm value.*

2.5.3. The Effect of COVID-19 on the Relationship Between GHG Emission Performance and Environmental Performance

COVID-19 threat and challenge firms around the world. COVID-19 has slowed economic growth worldwide and has had a serious impact on most industries, such as travel, health care, tourism, and various other sectors and made a significant reduction in productivity, consumption, processes, sales, and potential cash flow (Makni, 2023; Zhang & Zheng, 2022). The cessation of economic activity due to the COVID-19 crisis has resulted in financial constraints on firms due to increased uncertainty and decreased the firm value. The declining activity in the economy has resulted in a reduction in global carbon emissions in the short term, but the long-term impact of the pandemic on the transition to a low-carbon economy is uncertain (Guérin & Suntheim, 2021). Tighter financial constraints and poor economic conditions are generally detrimental to decreasing productivity and profitability because the firms withhold investment in assets.

***Hypothesis 3a:** COVID-19 has a negative effect on the impact of emissions GHG performance on ROA.*

Strong GHG emission performance during the COVID-19 period increased company access to external financing. In addition, the company's GHG emission performance can reduce adverse effects when the market and the company experience negative shocks. Positive GHG emission performance provides trust and assurance to stakeholders even during periods of crisis or when the company experiences uncertainty (Wellalage, Kumar, Hunjra, & Al-Faryan, 2022). COVID-19 strengthens the impact between emission performance on firm value because firms with good emission performance have positive incentives from investors. The hypothesis built is as follows:

***Hypothesis 3b:** COVID-19 has a positive effect on the impact of emissions GHG performance on firm value.*

3. Research Methods

This study is explanatory research that aims to analyze the impact of the firm's GHG emission performance to reduce greenhouse gas emissions on the firm's financial performance which is moderated by financial constraints and Covid-19 as seen in figure 1. The population of this study is non-financial sectors listed on the Indonesia Stock Exchange. The total population is 720 firms, then the population was reduced using purposive sampling, where only firms that were listed on the Indonesia Stock Exchange before 2018, consistently reporting annual reports

in the period 2019 to 2021, present their financial statements in rupiah, and reporting total greenhouse gas emissions for the period 2019-2021 in tons eq CO₂ or kg eq CO₂. Then, the sample of this study is 105 firms and the total observation is 315.

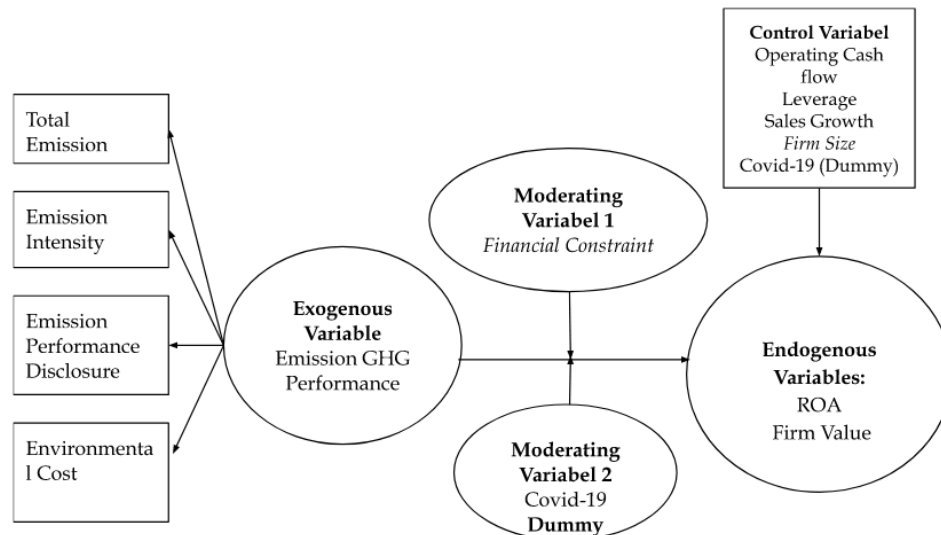


Figure 1. Research Model

The dependent variable that will be tested in this study is financial performance as measured using profitability ratios are Return on Assets (ROA) (Dang et al., 2022; Fan et al., 2020) and the firm value measured using Tobin's Q (Dang et al., 2022; Fan et al., 2020; Benkraiem et al., 2022). The independent variable in this study is GHG emissions performance as measured using several constructs: total emission transform using natural algorithm, emission intensity by comparing the number of carbon emissions with total revenue (Benkraiem et al., 2022), environmental cost transformed using the natural algorithm (Dang et al., 2022), and disclosure of GHG emission performance is measured using content analysis (Fan et al., 2020) with reference from several guidelines such as: the Global Reporting Initiative (GRI) guidelines, TCFD framework, and Sustainable Development Goals. The moderating variable in this study is Covid-19 and financial constraints as measured using the KZ index (Wu & Huang, 2022; Zhang & Jin, 2021). Control variables in this study are operating cash, sales growth, leverage, firm size and Covid-19 by giving the notation 1 and 0 for the year does not in period Covid-19.

Descriptive statistics are a method used for grouping, summarizing, organizing, and presenting data in an informative manner. The results of the descriptive analysis found that the processed data had many outliers, which were identified through boxplot diagrams. Because the amount of data in this study was limited to 315 observations, the outliers data could not be removed but modified as data with extreme values by winsorizing. The extreme elements is replaced with values that close to the average standard deviation in percentile range is 5%. After the winsorizing is done, a descriptive analysis is repeated.

This research uses the Structural Equations Models - Partial Least Square method because this method allows the model to be estimated in a complex manner with many explanatory constructs from the dependent variable. In this study, the emission GHG performance variable is a latent variable where can be measured using several constructs or indicators, total GHG emissions, GHG emission intensity, disclosure of GHG emission performance, and environmental costs.

4. Results and Discussion

4.1. Result

4.1.1. Descriptive Analysis Result

Descriptive analysis was carried out on data that had been transformed using the winsorizing method. The results of the descriptive analysis can be seen in table 1 which shows descriptive statistics of each variable with a total of 210 observations during the Covid-19 and 105 observations when the Covid-19 did not occur.

Table 1. Descriptive Statistics

		N	Mean	Std. Deviation	Std. Error Mean
Emission Disclosure	Before COVID-19	105	0.13	0.20	0.02
	COVID-19	210	0.31	0.22	0.02
Total Emission (Ln)	Before COVID-19	105	10.45	2.58	0.25
	COVID-19	210	10.40	2.58	0.18
Intensity Emissions	Before COVID-19	105	0.07	0.15	0.02
	COVID-19	210	0.10	0.22	0.02
Environmental Cost	Before COVID-19	105	0.43	0.50	0.05
	COVID-19	210	0.54	0.50	0.03
ROA	Before COVID-19	105	2.53	7.24	0.71
	COVID-19	210	5.06	6.72	0.46
Tobin's Q	Before COVID-19	105	2.00	1.25	0.12
	COVID-19	210	1.50	0.92	0.06
KZ Index	Before COVID-19	105	-2.07	5.16	0.50
	COVID-19	210	-2.10	5.25	0.36
DER	Before COVID-19	105	54.96	53.65	5.24
	COVID-19	210	55.93	56.86	3.92
OCF Ratio	Before COVID-19	105	1.02	1.73	0.17
	COVID-19	210	1.45	3.49	0.24
Sales Growth	Before COVID-19	105	0.04	0.33	0.03
	COVID-19	210	0.05	0.32	0.02
Firm Size	Before COVID-19	105	15.22	1.87	0.18
	COVID-19	210	15.55	1.48	0.10

During COVID-19, corporate emission performance disclosure was higher with an average value of 0.31, compared to before COVID-19 with an average value of 0.13. The number of emissions was higher before COVID-19, with average the natural algorithm of total emissions is 10.45. Whereas, the intensity of emissions is higher after COVID-19, with an

average intensity of carbon emissions compared to income is 0.10, even though there are decreasing in the number of emissions, income during COVID-19 more decreased, causing the intensity of emissions during COVID-19 to be higher. The environmental costs incurred during COVID-19 were higher than before COVID-19, with an average natural algorithm of 0.54.

This study found a unique phenomenon where the Return on Assets (ROA) is higher during COVID-19, with an average of 5.06, that means firm use their resource to generate profits more effectively during COVID-19. The company had a higher firm value before COVID-19, with an average Tobin's Q of 2.00 but firms had higher financial constraints before COVID-19, with an average KZ Index of -2.07. The proportion of debt to firms' equity is greater during COVID-19, with an average value of 55.93. The company's operating cash flow is higher during COVID-19 with an average of 1.45. Sales growth also shows a higher average during COVID-19. Likewise, the firm size was larger during COVID-19 compared to before COVID-19 with average natural algorithm of assets is 15.55.

4.1.2. Partial Least Square-Structural Equation Modeling

Partial Least Square Structural Equation Modeling (PLS-SEM) analysis using the SmartPLS.3.0 application. The following is a schematic of the estimated specification model that shows the relationship from this study:

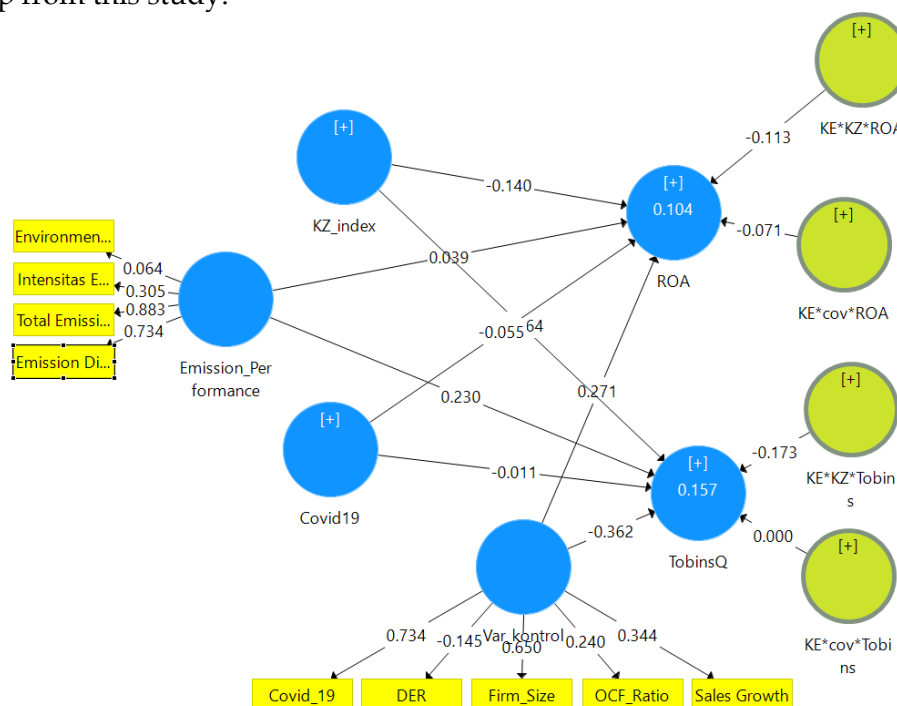


Figure 2. PLS-SEM Model Specification Estimation

Measurement Model Testing (Outer Model)

The first stage carried out in PLS-SEM processing is to analyze the measurement model. Analysis of the measurement model is analyzed using the Confirmatory Factor Analysis (CFA) method which aims to determine whether the observed variables or theoretically determined research indicators represent related latent variables in the research model. Measurement model analysis consists of validity analysis and reliability analysis:

a. Convergent Validity Testing

The convergence validity test is done by looking at the value of the outer loading or loading factor of each indicator against the construct. An indicator is valid if the absolute value of the loading factor is ≥ 0.50 . This means that indicators that have an absolute value of loading factor < 0.50 will be removed and retested. The following are the results of convergent validity testing based on the loading factor value:

Tabel 2. Convergent Validity Testing Result

Variable		Outer Loading	Result
GHG emission Performance	Disclosure of Emission	0.734	Valid
	Emission Intensity	0.305	Not Valid
	Total Emission	0.883	Valid
	Environmental Cost	0.064	Not Valid
Return on Assets	ROA	1.000	Valid
Firm Value	Tobin's Q	1.000	Valid
Financial Constraint	KZ Index	1.000	Valid
COVID-19		1.000	Valid
Control Variables	COVID-19	0.734	Valid
	DER	-0.145	Not Valid
	Firm size	0.650	Valid
	OCF	0.240	Not Valid
	Sales Growth	0.344	Not Valid

Based on Figure 2 and Table 2, there are five indicators that are not valid, because they have a loading factor value below 0.5. The five indicators are environmental management cost and emission intensity indicators on GHG emission performance variables, and sales growth indicators, Debt to Equity Ratio (DER), and operating cash flow on control variables. From this convergent validity analysis, it can be concluded that the environmental management cost and emission intensity does not explain the GHG emission performance variable, so it is excluded from the model. Thus, the rest of invalid control variables will be eliminated in the analysis of this study. Re-testing with a model without invalid indicators is shown in Figure 3.

b. Discriminant Validity Testing

Discriminant validity is carried out to ensure that each concept of each latent variable is different from the other variables. Discriminant validity can be measured based on the average variance extracted (AVE) value. A good and acceptable AVE value is 0.50 or more. The following is the average variance extracted (AVE) value in this study:

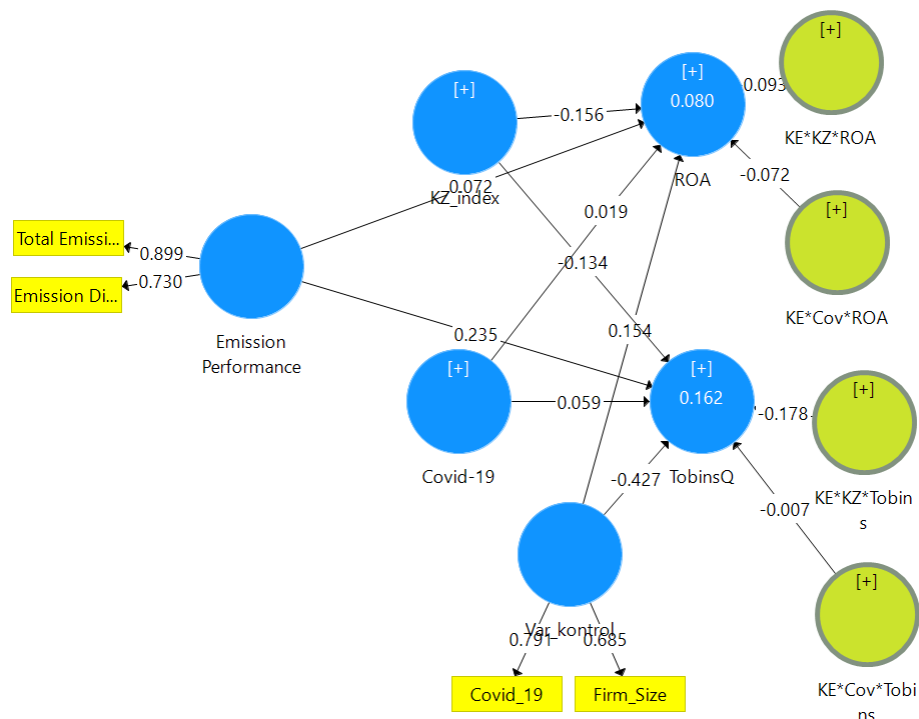


Figure 3. Model PLS-SEM

Table 3. Discriminant Validity Testing Result

Variable	Average Variance Extracted (AVE)
GHG emission Performance	0.670
Return on Assets	1.000
Firm Value	1.000
COVID-19	1.000
Financial Constraint	1.000
Control Variable	0.548

Table 4. Fornell-Lacker Criterion Test Result

Variable	Covid-19	Emission Performance	Financial Constraint	Return on Assets	Firm Value	Control Variable
Covid-19	1.000					
Emission Performance	0.162	0.819				
Financial Constraint	-0.002	-0.028	1.000			
Return on Assets	0.171	0.137	-0.145	1.000		
Firm Value	-0.220	0.061	-0.152	0.120	1.000	
Control Variable	0.791	0.409	0.030	0.206	-0.280	0.740

Based on the results of the Fornell Larcker criterion test in Table 4, the square root value of the Average Variance Extracted for each construct is greater than the correlation value between constructs and other constructs in the model. So that the discriminant validity

requirements have been met.

c. Reliability Testing

A construct has good reliability, or a construct is used as a reliable and consistent research tool if the composite reliability value is ≥ 0.70 . The following are the results of reliability testing:

Table 5. Reliability Testing Result

Variable	Composite Reliability
GHG emission performance	0.801
Return on Assets	1.000
Firm Value	1.000
COVID-19	1.000
Financial Constraint	1.000
Control Variable	0.707

Table 5 shows that the value of Cronbach's Alpha ≥ 0.70 and composite reliability ≥ 0.7 , so it can be concluded that all constructs have met the reliability required for this study to be reliable, consistent and feasible to do research, but the control variables have not fulfilled the reliability required for reliable research.

Structural Model Testing (Inner Model)

After testing the measurement model (outer model) that meets the requirements, namely that it meets the requirements for convergent validity, discriminant validity and reliability and the model is fit, then the next step is to test the structural model (inner model). In testing the structural model will be used to test the research hypothesis. In this study, the significance level used by the researcher was 5% with the one-tailed method. The t-one tailed significance value of 5% is 1.645 (absolute), where the significant value of t is less than -1.645 and greater than 1.645. Thus, if the t-statistic value is > 1.645 or the p-value is ≤ 0.05 , it will indicate a positive significant influence on a relationship between variables. The following are the results of testing the structural model or testing the hypothesis with the bootstrapping technique:

Table 6. Hypothesis Test Result

Hypothesis	Original Sample (O)	T statistic	P-Value	Result
1a	0.072	1.220	0.111	Rejected
1b	0.235	3.400	0.000	Accepted
2a	-0.093	1.116	0.132	Rejected
2b	-0.178	2.927	0.002	Accepted
3a	-0.072	1.338	0.091	Rejected
3b	-0.007	0.147	0.442	Rejected

Based on the results of structural model testing or hypothesis testing in Table 6, the accepted hypothesis:

Hypothesis 1b. The GHG emission performance variable on firm value has a p value of 0.000 with a t-statistic of 3.400 and a positive path coefficient of 0.235. Because the p-value obtained is less than 0.05 and the t statistic is more than 1.645, it can be concluded that hypothesis 1b is accepted, which means that there is a significant positive effect between the emission GHG performance and the company's value level.

Hypothesis 2b. The effect of financial constraint on the impact of GHG emission performance variable on firm value has a p value of 0.002 with a t-statistic of 2.927 and a negative path coefficient of -0.178. Because the p-value obtained is less than 0.05 and the t statistic is more than 1.645, it can be concluded that hypothesis 1b is accepted, which means that there is a significant positive effect between the GHG emissions performance, and the firms value level and financial constraint weaken the impact of GHG emissions on firm value.

4.2. Discussion

4.2.1 *Effect of Carbon Emissions Performance on Financial Performance*

Based on the results of the PLS-SEM analysis that has been carried out, it is known that GHG emissions performance as measured using the indicators of the amount of GHG emissions, and disclosure of GHG emission performance has no significant effect on Return on Assets (ROA). The existence of carbon pricing regulations turns carbon emissions into costs that are internalized by the company, which implies that the company's marginal returns will decrease due to high carbon emissions. (Dam & Scholtens, 2015). When carbon emissions become more expensive, companies with low-carbon production technologies gain an advantage over companies with high amounts of carbon emissions. Indonesia has not enacted this regulation so that company profits are not affected by taxes or fees caused by carbon emissions other than voluntary management fees and that increases or decreases in GHG emission performance do not affect a company's Return on Assets (ROA).

The GHG emission performance has a significant impact on firm value, increasing company compliance with GHG emission regulations and efforts to reduce GHG emissions increase firm value. This is in accordance with research by Benkraiem et al. (2022), Gallego-Álvarez et al. (2015), & Hart (1995) that the value relevance of emission performance is increasing firm value. This supports the theory of a resource-based view, which shows that the stock market responds positively to the effort of reducing GHG emission performance, emissions GHG is considered as competitive advantage. On the other hand, companies with high carbon emissions have obligations to convey risks and have a responsibility to improve the environment.

4.2.2 *Effect of Carbon Emissions Performance on Financial Performance Moderating by Financial Constraints*

Financial constraints are measured using the KZ Index where the greater the value of the KZ Index, the greater the company's financial constraints. The negative impact of financial constraint on the impact between GHG emission performance and financial value indicates if firm have a good GHG emission performance, it will drive firm to have access to funding, firm is not financially restricted, and it can increase the company's ability to increase its firm value.

The research results are not significant impact of GHG emission performance to ROA because ESG practices are not effective yet, especially ESG-based investments have just been implemented in the last few years, where regulations regarding ESG disclosure are still voluntary. According to data from the Financial Services Authority, ESG-based mutual funds

in 2019 were worth 1.7 trillion rupiah, of the total management of mutual fund funds of 542.17 trillion or 0.31%, in 2020 of 3.07 trillion of the total management of mutual fund funds, namely 573.54 trillion or 0.5%, and in 2021 of 3.5 trillion of the total management of 580.14 trillion mutual funds or 0.6%, the availability of access to ESG-based funding which is still minimal is one of the factors that makes financial constraints have no significant effect between the impact of GHG emission performance on firm profitability.

4.2.3 Effect of Carbon Emissions Performance on Financial Performance Moderating by Covid-19

COVID-19 moderation does not have a significant effect on the impact GHG emission performance to ROA and firm value. COVID-19 creates uncertainty for companies and worsens company performance (Hu & Zhang, 2021). When a company experiences a crisis, it reduces environmental investment because when a company invests in the environment, it reduces the company's financial performance. Profitability and productivity have a significant effect on predicting firm value, and when the COVID-19 pandemic occurs, companies experience negative abnormal returns, thereby reducing firm value. This insignificant result is because the company's drive to improve GHG emission performance is not based on the COVID-19 crisis but on the ESG practice that is currently developing in Indonesia.

5. Conclusion

Based on the results of the research conducted, it is concluded that the GHG emission performance measured using the amount of GHG emissions, and disclosure of GHG emissions has a significant positive impact on firm value where good GHG emission performance gives a positive signal to investors because it is seen as a competitive advantage that can increase company value. The financial constraint significantly weakens the impact GHG emission performance on firm value. Green investment practices have provided a strong impetus for companies to gain access to external funding through good GHG emission performance, and because of that funding firm can increase productivity and profitability. Covid-19 did not significantly strengthen or weaken the impact of GHG emission performance on Return on Assets (ROA) and firm value. Because the practice of compliance on GHG emission regulation is not based on the crisis caused by Covid-19 but because of the trend of increasing ESG in Indonesia.

This research has implications for managers where companies need to pay attention to performance because it affects firm value. Managerial needs to consider various efforts to reduce the number of emissions. When a firm considers making an investment, managers can consider investing in the environment comply firm, use of alternative renewable energy, or environmentally friendly equipment. In addition, companies are advised to comply with GHG emission regulations by disclosing their GHG emission performance in the company's Annual Report and Sustainability Report in a comprehensive disclosure to provide comprehensive information to stakeholders to assess the company's GHG emission performance.

This research shows that there is a significant positive effect between GHG emission performance and firm value where the disclosure of GHG emissions is still voluntary and has not been carried out comprehensively, therefore this research can be carried out again in the 2021 period and thereafter to be able to provide better results. This research needs to be developed because this research only measured Covid-19 and financial constraints as moderating variables, but there are systematic risks and other non-systematic risks that might affect the impact GHG emission performance to financial performance so that this can be considered for further research. Future research also needs to find the other factors that can be

used as constructs for GHG emission performance variables.

References

- Abeyssekara, W. C. S. M., Siriwardana, M., & Meng, S. (2023). Economic consequences of climate change impacts on the agricultural sector of South Asia: A case study of Sri Lanka. *Economic Analysis and Policy*, 77, 435–450. <https://doi.org/10.1016/j.eap.2022.12.003>
- Barney, J. B. (1993). *Looking inside for Competitive Advantage* (Vol. 9).
- Benkraiem, R., Shuwaikh, F., Lakhal, F., & Guizani, A. (2022). Carbon performance and firm value of the World's most sustainable companies. *Economic Modelling*, 116. <https://doi.org/10.1016/j.econmod.2022.106002>
- Brammer, S., Jackson, G., & Matten, D. (2012). Corporate social responsibility and institutional theory: New perspectives on private governance. *Socio-Economic Review*, 10(1), 3–28. <https://doi.org/10.1093/ser/mwr030>
- Cherchye, L., De Rock, B., Ferrando, A., Mulier, K., & Verschelde, M. (n.d.). Working Paper Series Identifying financial constraints. <https://doi.org/10.2866/890948>
- Choi, B., & Luo, L. (2021). Does the market value greenhouse gas emissions? Evidence from multi-country firm data. *British Accounting Review*, 53(1). <https://doi.org/10.1016/j.bar.2020.100909>
- Clarkson, P. M., Li, Y., & Richardson, G. D. (2004). The Market Valuation of Environmental Capital Expenditures by Pulp and Paper Companies. In *Source: The Accounting Review* (Vol. 79).
- Cortez, M. C., Andrade, N., & Silva, F. (2022). The environmental and financial performance of green energy investments: European evidence. *Ecological Economics*, 197. <https://doi.org/10.1016/j.ecolecon.2022.107427>
- Dam, L., & Scholtens, B. (2015). Toward a theory of responsible investing: On the economic foundations of corporate social responsibility. *Resource and Energy Economics*, 41, 103–121. <https://doi.org/10.1016/j.reseneeco.2015.04.008>
- Dang, T. V., Wang, Y., & Wang, Z. (2022). The role of financial constraints in firm investment under pollution abatement regulation. *Journal of Corporate Finance*, 76. <https://doi.org/10.1016/j.jcorpfin.2022.102252>
- Dixon-Fowler, H. R., Slater, D. J., Johnson, J. L., Ellstrand, A. E., & Romi, A. M. (2013, January 1). Beyond “Does it Pay to be Green?” A Meta-Analysis of Moderators of the CEP-CFP Relationship. *Journal of Business Ethics*, Vol. 112, pp. 353–366. Kluwer Academic Publishers. <https://doi.org/10.1007/s10551-012-1268-8>
- Fan, L., Yang, K., & Liu, L. (2020). New media environment, environmental information disclosure and firm valuation: Evidence from high-polluting enterprises in China. *Journal of Cleaner Production*, 277. <https://doi.org/10.1016/j.jclepro.2020.123253>
- Fu, K., Li, Y., Mao, H., & Miao, Z. (2023). Firms' production and green technology strategies: The role of emission asymmetry and carbon taxes. *European Journal of Operational Research*, 305(3), 1100–1112. <https://doi.org/10.1016/j.ejor.2022.06.024>
- Gallego-Álvarez, I., Segura, L., & Martínez-Ferrero, J. (2015). Carbon emission reduction: The impact on the financial and operational performance of international companies. *Journal of Cleaner Production*, 103, 149–159. <https://doi.org/10.1016/j.jclepro.2014.08.047>
- Gray, W. B., Shadbegian, R. J., & GRAYt, W. B. (1998). Environmental Regulation, Investment Timing, and Technology Choice ENVIRONMENTAL REGULATION, INVESTMENT TIMING, AND TECHNOLOGY CHOICE*. In *Source: The Journal of Industrial Economics* (Vol. 46).

- Guérin, P., & Suntheim, F. (2021). Firms' environmental performance and the COVID-19 crisis. *Economics Letters*, 205. <https://doi.org/10.1016/j.econlet.2021.109956>
- Hailemariam, A., Ivanovski, K., & Dzhumashev, R. (2022). Does R&D investment in renewable energy technologies reduce greenhouse gas emissions? *Applied Energy*, 327. <https://doi.org/10.1016/j.apenergy.2022.120056>
- Hart, S. L. (1995). A Natural-Resource-Based View of the Firm. In *Source: The Academy of Management Review* (Vol. 20). Retrieved from <https://www.jstor.org/stable/258963>
- Hu, S., & Zhang, Y. (2021). COVID-19 pandemic and firm performance: Cross-country evidence. *International Review of Economics and Finance*, 74, 365–372. <https://doi.org/10.1016/j.iref.2021.03.016>
- Kaplan, S. N., & Zingales, L. (n.d.). Do Investment-Cash Flow Sensitivities Provide Useful Measures Of Financing Constraints?*
- Makni, M. S. (2023). Analyzing the impact of COVID-19 on the performance of listed firms in Saudi market. *Technological Forecasting and Social Change*, 187. <https://doi.org/10.1016/j.techfore.2022.122171>
- Margaritis, D., & Psillaki, M. (2010). Capital structure, equity ownership and firm performance. *Journal of Banking and Finance*, 34(3), 621–632. <https://doi.org/10.1016/j.jbankfin.2009.08.023>
- Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *Accounting Review*, 89(2), 695–724. <https://doi.org/10.2308/accr-50629>
- Palmer, K., Oates, W. E., & Portney, P. R. (1995). Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm? In *Source: The Journal of Economic Perspectives* (Vol. 9). Autumn.
- Porter, M. E., & Van Der Linde, C. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. In *Source: The Journal of Economic Perspectives* (Vol. 9). Autumn.
- Rahman, M. (2023). The virtuous circle between green product innovation and performance: The role of financial constraint and corporate brand. *Journal of Business Research*, 154. <https://doi.org/10.1016/j.jbusres.2022.09.001>
- Saka, C., & Oshika, T. (2014). Disclosure effects, carbon emissions and corporate value. *Sustainability Accounting, Management and Policy Journal*, 5(1), 22–45. <https://doi.org/10.1108/SAMPJ-09-2012-0030>
- Telle, K. (2006, November). "It pays to be green" - A premature conclusion? *Environmental and Resource Economics*, Vol. 35, pp. 195–220. <https://doi.org/10.1007/s10640-006-9013-3>
- Trinks, A., Mulder, M., & Scholtens, B. (2020). An Efficiency Perspective on Carbon Emissions and Financial Performance. *Ecological Economics*, 175. <https://doi.org/10.1016/j.ecolecon.2020.106632>
- Wellalage, N. H., Kumar, V., Hunjra, A. I., & Al-Faryan, M. A. S. (2022). Environmental performance and firm financing during COVID-19 outbreaks: Evidence from SMEs. *Finance Research Letters*, 47. <https://doi.org/10.1016/j.frl.2021.102568>
- Wu, Y., & Huang, S. (2022). The effects of digital finance and financial constraint on financial performance: Firm-level evidence from China's new energy enterprises. *Energy Economics*, 112. <https://doi.org/10.1016/j.eneco.2022.106158>
- Yang, Z., Zhang, M., Liu, L., & Zhou, D. (2022). Can renewable energy investment reduce carbon dioxide emissions? Evidence from scale and structure. *Energy Economics*, 112. <https://doi.org/10.1016/j.eneco.2022.106181>
- Yi, Y., Zhang, Z., & Xiang, C. (2022). The value of CSR during the COVID-19 crisis: Evidence

- from Chinese firms. *Pacific Basin Finance Journal*, 74.
<https://doi.org/10.1016/j.pacfin.2022.101795>
- Zhang, D., & Jin, Y. (2021). R&D and environmentally induced innovation: Does financial constraint play a facilitating role? *International Review of Financial Analysis*, 78.
<https://doi.org/10.1016/j.irfa.2021.101918>
- Zhang, D., & Zheng, W. (2022). Does COVID-19 make the firms' performance worse? Evidence from the Chinese listed companies. *Economic Analysis and Policy*, 74, 560-570.
<https://doi.org/10.1016/j.eap.2022.03.001>