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Do firms financially benefit from optimizing GHG performance? Evidence from Indonesian firms

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Abstract

This study investigates the impact of GHG performance (measured by (1) the disclosure of information on GHG emissions and (2) the amount of GHG emissions) towards the financial performance and stock market performance of publicly listed Indonesian firms. The financial performance is measured using four performance measures: Return on Equity (ROE), Return on Assets (ROA), Earnings per Share (EPS) and Tobin's q. The stock market performance is measured by using the expected stock returns, which is calculated using the Capital Asset Pricing Model (CAPM). The main findings of this research is that neither the disclosure of information on GHG emissions and the amount of GHG emissions have a significant effect on any of the four financial performance measures. On the other hand, the disclosure of information on GHG emissions does have a significant effect on the expected stock returns. However, the negative coefficient is in contrast to one of our hypotheses, which assumed that firms that disclose information on their GHG performance have stronger stock market performance than firms that do not disclose. Overall, this study has opened room for more research on the current behavior of Indonesian firms and its (external) stakeholders. This can therefore help regulators make decisions with this information to achieve their (environmental) objectives, and help Indonesian firms strategize on their behaviors accordingly to maximize their firm performance.

1. Introduction

Over recent years, society has paid increasing attention towards environmental and social issues. This has pressured firms to take action in efforts of fulfilling social responsibility. Although there have been many concerns regarding environmental issues such as the consumption/use of water, energy, biodiversity and so on, this research focuses on one particular issue that is measurable and representative to what many different organizations have been trying to minimize: greenhouse gas emissions (GHG). Given that the vast majority of these GHG emissions are represented by carbon emissions (CO2), this research uses carbon emissions as a representative the GHG emitted by these firms.

Existing literatures have found evidence that carbon emissions do have a negative correlation towards financial performance. However, most research pertaining to this topic only focuses on developed economies, particularly in the US and Europe, and in regions where firms are obligated to disclose information regarding their carbon emission performance. Therefore, this study will focus on an emerging economy: Indonesia. This brings us into our main research question:

Do Indonesian firms financially benefit from optimizing GHG performance?

There are several motivations on why this research focuses on Indonesian firms: (1) To have a better understanding on the behavior of Indonesian firms and their stakeholders towards environmental-related performance. The disclosure of carbon emission is still considered a voluntary disclosure for Indonesian firms. Therefore, this has brought room for more research pertaining this issue given the growing concern on environmental issues in recent years. (2) To have a better understanding on how the market rewards sustainability practices of Indonesian firms. Over the past decades the main purpose of Indonesian firms is to maximize profits for its stakeholders (i.e. to attract potential investments, maximize dividends for shareholders, etc.). The environmental awareness amongst shareholders in Indonesia is not as established as those in developed economies. Therefore, the outcome of this research could help regulators make decisions to achieve (environmental) objectives, and help Indonesian firms strategize on their behaviors accordingly to maximize their firm performance.

The financial performance of firms is arguably the most important way in measuring firm performance, as this informs various stakeholders about the firm's general well-being. Furthermore, based on the popular approach in valuing a firm (e.g. Discounted Cash Flow Method), the profitability of firms is often reflected in the stock price of a firm. However, given

the evolving behaviors of investors and the growing importance of taking sustainability efforts, the stock market is slowly growing into becoming a benchmark on how the general public perceives these firms. Therefore, by including both financial and stock market performance in our research question, we are able to differentiate our analysis into two parts: (1) whether taking such sustainability efforts would lead to a profitable outcome and (2) whether these firms will be rewarded by the general public for taking such sustainability efforts.

To address the first motivation regarding our focus towards Indonesian firms, the first sub-question can be derived:

Sub-Question 1: Do firms that disclose information on their GHG performance have stronger financial and stock market performance than firms that do not disclose?

After answering the first sub-question, we can further answer our main research question by investigating the straightforward relationship of GHG performance on the financial and stock market performance of firms. From here, the second sub-question is derived:

Sub-Question 2: Do firms with better GHG performance have stronger financial and stock market performance?

Answering both of these sub-questions could give us a concrete answer to our main research question. Depending on the outcome of this research, this paper can provide two possible contributions: (1) if improving carbon performance leads to a more profitable outcome, then firms are incentivized to improve their GHG performance; thus firms will make efforts in disclosing information on their GHG performance. Therefore, the efforts of minimizing GHG emissions can be solved by the market itself without government interference. Otherwise, (2) if improving GHG performance does not lead to a more profitable outcome, then new regulations should be made in order to incentivize firms to disclose information on their GHG performance and to take efforts in minimizing GHG emissions.

2. Literature Review

As mentioned previously, various literatures have studied the impact of carbon emissions on the financial performance and stock market performance of firms. This section will explore existing literatures regarding this topic, and will give the following contributions to this research: (1) to understand the motives on why firms disclose and minimize GHG emissions, and how the environmental awareness of stakeholders influences these motives, and (2) to get a clearer idea on relationship of financial performance / stock market performance of firms in different types of economies.

2.1. Legitimacy Theory

Dowling and Pfeffer (1975) explain the role of legitimacy theory in organizational behavior as the constraints imposed by society and values, and the reactions to such constraints gives a focus on analyzing behaviors of organizations with respect to the environment. Furthermore, legitimacy theory encourages companies to make sure that their performance and activities are acceptable by the social norms. Therefore, the legitimacy theory may explain why firms may decide to disclose information on carbon emissions.

2.2. Stakeholder Theory

Ruf et al. (2001) explains that firms must understand and take into account the demands of their stakeholders when making decisions. Failing to meet the demands of their stakeholders will result to firms facing negative confrontations from non-shareholder groups, which can lead to diminished shareholder value through boycotts, lawsuits, protests, etc. Therefore, by applying this theory to GHG performance, firms could be pressured to disclose information of their emissions as a way to express their efforts in fulfilling the demands of their stakeholders.

2.3. Carbon Disclosure and Regulatory Framework in Indonesia

In 1995, the Indonesian Environmental Impact and Management Agency (BAPEDAL) established PROPER, which is a program that uses color-coded environmental performance ratings that is intended to fulfill the following objectives: to promote industrial compliance with pollution control regulations, to facilitate and enforce the adoption of practices contributing to "clean technology," and to ensure a better environmental management system (Torres & Kanungo, 2003). Furthermore, Blackman et al. (2004) found in a survey that the most important role of the PROPER rating system in improving the environmental performance of firms is "providing information to plant managers and owners about their own plant's emissions and abatement opportunities".

Solikah et al. (2020) found that the level of carbon disclosure in manufacturing companies in Indonesia is still relatively low with an average value of 18.8%. This is highly attributed by the fact that disclosure of carbon emissions is still a voluntary disclosure in Indonesia. There may have been several factors in Indonesia that may explain why the level of carbon disclosure in Indonesia is still relatively low. Nurdiawansyah et al. (2018) found some observations, stating that the size of a company has a positive and significant effect on carbon emissions disclosure. This implies that larger companies are "encouraged to provide qualified voluntary disclosure to gain legitimacy and disclose detailed information related to pollution". Furthermore, profitability and media exposure also has a positive and significant effect on carbon emissions disclosure at manufacturing companies in Indonesia.

2.4. Behavior of Indonesian Investors

It is safe to say that investors are one of the most important stakeholders for any firm. Furthermore, firms set their priorities on maximizing their financial performance knowing that investors will make a decision depending on the results. Listyarti et al. (2014) conducted a survey design that involved 190 individual investors in three big cities in Indonesia (Jakarta, Surabaya, and Bandung), and found that financial information has a significant effect on the investors' intensions and their investment decisions. Furthermore, they also found that subjective norms that would usually have a significant effect on investor intention turned out to not have a significant effect. They later concluded that the attitude of Indonesian investors is rational. Fransiska et al. (2018) did a research that attempts to investigate the herding behavior of investors who invested in the IDX LQ45 Index from 2014 to 2016. They found that there is a dynamic between behavior and size, implying that a high market capitalization would lead to intense herd behavior; and intense herd behavior would lead to an increase in market capitalization.

2.5. Carbon Emissions and Financial Performance: Empirical Evidence

Trinks et al. (2020) used an international sample of 1572 firms over the years 2009-2017 and found that carbon efficient firms seem to have a more superior financial performance. This finding has helped better understand the growing interest in corporate emission disclosure and reduction, especially in industries that are environmentally sensitive.

Alvarez et al. (2015) also made use of international data consisting of 89 companies from the years 2006 to 2009 and found that there is a positive impact on emission reductions on financial performance. This effect has improved business competitiveness and "leads to

competitive advantage compared with their less proactive competitors". Therefore, there is room for firms to obtain competitive advantage by implementing environmental strategies that are "difficult to imitate". Lewandowski (2017) collected data on 175 countries and 60 markets and found that there is a curvilinear association between annually reported carbon emissions and financial performance. This implies that firms face little incentive to improve their carbon performance once they have already reached the minimum required level of carbon performance. Brouwers et al. (2018) collected a sample of 368 European listed firms with over the period 2005–2012, and found that emission performance is positively related with economic performance. However, carbon efficiency does not necessarily lead to better corporate financial performance when the research explicitly takes into account the industry and firm characteristics.

Miah et al. (2021) did a research on the same topic but on selected emerging economies. They observed that carbon emissions reduce the Tobin's q for both financial and non-financial firms. The observations found in this paper suggests that managers of firms "should consider carbon mitigation strategies seriously because carbon emissions negatively affect shareholder value". Desai et al. (2021) have explored this topic in the context of an emerging economy such as India. By studying on Indian companies from 2013 to 2019, they found that carbon emission has a significant negative impact towards both accounting-based and market-based financial performance. Furthermore, firms that operate in sensitive industries tend to be more exposed to environmental risk and should therefore "consider it while analyzing their business activities as well as plans." Sarumpaet (2005) explored this topic in the context of Indonesian firms from 1996 to 1999, and found no association between environmental performance and financial performance, which they believed is not a surprising observation for developing countries.

2.6. Carbon Emissions and Stock Market Performance: Empirical Evidence

In et al. (2017) studied the relationship among firm-level decarbonization, financial characteristics and stock returns by analyzing 739 firms from 2005 to 2015. By constructing an EMI ("efficient-minus-inefficient") portfolio based on carbon intensity, the authors have found that the EMI portfolio had a large positive cumulative returns after 2009, which suggests that carbon-efficient firms tend to outperform carbon-inefficient firms in the stock market. Furthermore, the authors also found that carbon-efficient firms are found in those with lower book-to-market ratios, higher ROA, higher Tobin's q, higher free cash flows and cash holdings, higher coverage ratios, lower leverage ratios, and higher dividend payout ratios.

2.7. Hypothesis Development

As already mentioned, this study will focus on the relationship between carbon emission and the financial and stock market performance of Indonesian firms. Focusing on both financial and stock market performance will provide a concrete understanding of the relationship of GHG performance and financial performance of Indonesian firms.

Furthermore, existing literatures in Section 2.3. mentioned how carbon disclosure in Indonesia is still voluntary. By using the stakeholder theory assumption, the motivation on why firms decide to disclose such information can be seen as a strategic decision that can be beneficial for the firm. From here, the first two hypotheses for answering the first sub-question can be derived.

Hypothesis 1a: Firms that disclose information on their GHG performance have stronger financial performance than firms that do not disclose.

Hypothesis 1b: Firms that disclose information on their GHG performance have stronger stock market performance than firms that do not disclose.

Evidence from emerging markets give conflicting results regarding this relationship, as seen in the existing literatures from Section 2.5.. Given the environmental awareness amongst stakeholders and the lack of established measures on environmental performance in Indonesia, the next two hypotheses can be derived.

Hypothesis 2a: Firms with better GHG performance do not have a significantly stronger financial performance.

Hypothesis 2b: Firms with better GHG performance do not have a significantly stronger stock market performance.

3. Data and Methodology

3.1. Sample

Since this research narrows its focus on Indonesian firms, the sample consists of firms that are publicly listed in the Indonesian Stock Exchange (IDX). To measure the financial performance of firms (see Section 3.2.1.2.), the sample consists of firms from January 1, 2009 to December 31, 2021. To measure the stock market performance of firms (see Section 3.2.2.2.), the sample consists of firms from January 1, 2015 to December 31, 2021. Furthermore, the data based on Sections 3.2. is then collected from the sample. The raw data for calculating the financial performance (ROE, ROA, EPS and Tobin's q), stock market performance (monthly closing stock price) and GHG performance (according to the GHG Protocol) is collected from Refinitiv Eikon.

3.2. Methodology

3.2.1. Measuring GHG Performance, Financial and Stock Market Performance

3.2.1.1. Measuring GHG Performance

A standardized way to measure GHG performance is by using the Greenhouse Gas Protocol (GHG) Corporate Standard, where we measure the GHG emissions (Ranganathan et al., 2004). The GHG Protocol is one of the world's most widely used greenhouse gas accounting standards. Furthermore, it classifies greenhouse gas emissions into three scopes: Scope 1, Scope 2 and Scope 3.

Scope 1 emissions are the direct emissions from owned or controlled sources. This includes fuel combustion, company vehicles, fugitive emissions. Scope 2 emissions are indirect emissions generated from the purchased electricity, steam, heating and cooling consumed by the firm. Scope 3 emissions includes all the other indirect emissions that occur in the firm's value chain. A lot of the empirical studies have used Scope 1 and Scope 2 emissions as the measurement of GHG performance. However, given the availability of data of Indonesian firms in the Refinitiv Eikon database, this research will use the total CO_2 emissions as a measurement of the GHG emissions, which refers to the estimated total CO_2 and CO_2 equivalents emission, according to Refinitiv. Furthermore, the estimated total CO_2 and CO_2 equivalents emission will be measured in million tons.

In answering Sub-Question 1, we use a dummy variable called *disclosure*, wherein the variable equals to 1 if the firm discloses information on their GHG performance, and 0

otherwise. Furthermore, in answering the Sub-Question 2, we use a variable called *total_emissions*, which refers to the estimated total CO_2 and CO_2 equivalents emission.

3.2.1.2. Measuring Financial Performance

There are various ways in which financial performance can be measured. However, the most common way to measure the financial performance of a firm is by categorizing into types of financial performance: accounting-based financial performance and market-based financial performance. The most common way to calculate the accounting financial performance is by calculating the Return on Equity (ROE), Return on Assets (ROA) and Earnings per Share (EPS). Furthermore, the most common way to calculate the market financial performance is by calculating the Tobin's q, which is computed by dividing the market value of assets by the book value of assets.

3.2.1.3. Measuring Stock Market Performance

The stock market performance of a firm can be measured by modelling the Capital Asset Pricing Model (CAPM). For this research, the stock market performance is modelled only by using CAPM, since there is no publicly available data on the Fama and French (1993) constructed factors (e.g. size, value, momentum) in the Indonesian Stock Market. The expected stock returns using CAPM can be calculated using the following equation:

$$E(R_i) = R_f + \beta_i \, (E(R_m) - R_f)$$

Where:

$E(R_i)$ = Expected return of security

R_f = Risk-free rate

β_i = Sensitivity

$E(R_m)$ = Expected return of market

The risk-free rate is based on the Indonesia 10-year government bond yield for each year. The data on the sensitivity for each year is collected from Refinitiv Eikon. For calculating the expected market return, MSCI Indonesia Index is used as a representation of the Indonesian market, where the average returns of the market index for each year is calculated.

3.2.2. Control Variables

Company Size

Larger firms tend to get more attention from stakeholders including investors, government and regulators. Desai et al. (2021) found that firm size has a significant positive impact on environmental disclosure, which confirms the findings of Kumar and Firoz (2018) and Lee et al. (2013). Given the effect of firm size in this research, treating it as a control variable would be appropriate. For this research, company size will be referred as the total assets of the firm, measured in billion Indonesian Rupiah (IDR). Sarumpaet (2005) found that size (measured by total assets) are significant when finding the relationship of environmental performance and financial performance of Indonesian firms.

Industry Sector

Various literatures regarding this topic have included industry sector as a control variable. Trinks et al. (2020) found that the relationship between carbon efficiency and financial performance tend to be stronger in industries that are environmentally sensitive. A similar observation can be found amongst Indian firms (Desai et al., 2021). However, Sarumpaet (2005) observed that the industry sector does not have a significant effect on environmental performance. Despite conflicting observations regarding the role of the industry sector in this topic, it would be appropriate to include industry sector as a control variable. For this research, the data on the industry sector was collected from the Global Industry Classification Standard (GICS).

Tables 1 and 2 show the overview of our sample based on the GICS Sector. Samples with disclosure are defined as firms that disclose information on their GHG emissions. Furthermore, the following table also shows the overview of our sample distinguished into the relationship of GHG emissions with financial performance and stock market performance.

Table 1: Descriptive Statistics of Industry Sector (for Measuring Relationship with Financial Performance)

	All Samples		Samples with Disclosure	
GICS Sector Name	Freq.	Percent	Freq.	Percent
Communication Services	430	5.71	73	17.18
Consumer Discretionary	1057	14.04	23	5.41
Consumer Staples	907	12.05	71	16.71
Energy	609	8.09	64	15.06
Financials	1160	15.41	68	16.00
Health Care	230	3.06	11	2.59
Industrials	1221	16.22	16	3.76
Information Technology	196	2.60	1	0.24
Materials	900	11.96	60	14.12
Real Estate	764	10.15	27	6.35
Utilities	54	0.72	11	2.59
Total	7528	100.00	425	100.00

Table 2: Descriptive Statistics of Industry Sector (for Measuring Relationship with Stock Market Performance)

	All Samples		Samples with Disclosure	
GICS Sector Name	Freq.	Percent	Freq.	Percent
Communication Services	234	5.74	53	18.03
Consumer Discretionary	575	14.10	16	5.44
Consumer Staples	480	11.77	48	16.33
Energy	331	8.11	41	13.95
Financials	650	15.94	40	13.61
Health Care	115	2.82	7	2.38
Industrials	671	16.45	14	4.76
Information Technology	104	2.55	1	0.34
Materials	471	11.55	41	13.95
Real Estate	417	10.22	26	8.84
Utilities	31	0.76	7	2.38
Total	4,079	100.00	294	100.00

3.2.3. Regression Equation

Financial performance of the firms is measured using a panel data regression. In answering the first sub-question, the regression measures the relationship between the financial performance of the firm and whether the firm discloses information on GHG emissions.

The financial performance of the firm is treated as the dependent variable and its regression equation is performed according to the two types of measures: accounting-based performance (for measuring ROE, ROA, EPS) and market-based performance (for measuring Tobin's q). Furthermore, the stock market performance of the firm is also treated as the dependent variable and is measured using the expected stock returns, also seen in Section 3.2.1.3..

Effect on Financial Performance:

$$ROE_{it} = \beta_0 + \beta_1 Disclosure_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon$$
$$ROA_{it} = \beta_0 + \beta_1 Disclosure_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon$$
$$EPS_{it} = \beta_0 + \beta_1 Disclosure_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon$$
$$Tobins\_q_{it} = \beta_0 + \beta_1 Disclosure_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon$$

Effect on Stock Market Performance:

$$Returns_{it} = \beta_0 + \beta_1 Disclosure_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon$$

In answering the second sub-question, the following regression equation will be used:

Effect on Financial Performance:

$$ROE_{it} = \beta_0 + \beta_1 Total\_Emissions_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon_{it}$$
$$ROA_{it} = \beta_0 + \beta_1 Total\_Emissions_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon_{it}$$
$$EPS_{it} = \beta_0 + \beta_1 Total\_Emissions_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon_{it}$$
$$Tobins\_q_{it} = \beta_0 + \beta_1 Total\_Emissions_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon_{it}$$

Effect on Stock Market Performance:

$$Returns_{it} = \beta_0 + \beta_1 Total\_Emissions_{it} + \beta_2 Size_{it} + \beta_3 Sector_{it} + \beta_4 Year_{it} + \varepsilon_{it}$$

4. Results and Discussion

4.1. Descriptive Statistics

Table 3: Descriptive Statistics of Variables (All Samples)

Variable	Obs	Mean	Std. Dev.	Min	Max
ROE	7528	.023	17.056	-1374.16	272.151
ROA	7528	-.149	16.321	-1396.863	184.132
EPS	7528	1919.951	61583.613	-319652.81	4433462.5
Tobin's q	7528	3.95	67.167	0.00002	3805.89
Size	7528	15356.61	76967.93	.077939	1725611
Disclosure	7528	.056	.231	0	1
GHG Emissions	425	10.99892	185.893	.0005588	3832.75
Expected Return	4079	.0371162	.1061563	-.4287652	.6305364

Table 4: Descriptive Statistics of Variables (Samples with Carbon Disclosure)

Variable	Obs	Mean	Std. Dev.	Min	Max
ROE	425	.215	.568	-4.504	8.911
ROA	425	.086	.104	-.657	.458
EPS	425	465.665	805.077	-849.941	6177.804
Tobin's q	425	3.025	4.681	.192	34.93
Size	425	149396.6	279507.8	3412.954	1725611
Disclosure	-	-	-	-	-
GHG Emissions	425	10.99892	185.893	.0005588	3832.75
Expected Return	294	.0081275	.1351832	-.3790998	.4081888

Tables 3 and 4 show the number of observations, mean, standard deviation, the minimum and the maximum of each variable used in the regressions. As mentioned previously, the financial performance is measured using the accounting-based approach (ROE, ROA and EPS) and the market-based approach (Tobin's q). The stock market performance is measured by calculating the expected returns of the stock, using the Capital Asset Pricing Model (CAPM) approach.

The observations for finding the relationship between GHG emissions and financial performance were collected from the timeframe of January 1, 2009 to December 31, 2021, therefore consisting of 7528 observations. Given the availability of data, the observations for finding the relationship between GHG emissions and stock market performance are collected from the timeframe of January 1, 2015 to December 31, 2021, therefore consisting of 4079 observations.

Furthermore, the variable *disclosure* has a mean of 0.056, implying that only 5.6% of the full observations disclose information on GHG emissions. Therefore, when measuring the relationship of GHG emissions of both financial and stock market performance, only 5.6% of the full observations are selected, therefore having 425 and 294 observations respectively.

4.2. Heteroskedasticity Test

4.2.1. Testing for Heteroskedasticity (Impact of Disclosure on Financial and Stock Market Performance)

Table 5: Breusch-Pagan Test for heteroskedasticity for regression of financial and stock market performance on disclosure

H0: Constant variance					
	ROE	ROA	EPS	Tobin's q	Expected Return
chi2(1)	224.72	225.20	225.14	223.04	62.07
Prob > chi2	0.00	0.00	0.00	0.00	0.00

We first come up with five regressions on the relationship between disclosure and the financial performance (ROE, ROA, EPS and Tobin's q) and stock market performance (expected returns). The data is checked for heteroskedasticity to test whether the variance of the errors from each of the following regressions are dependent on the values of the independent variables. This is performed using a Breusch-Pagan test. The test gives a significant p-value, as shown in Table 5, thus implying that the data is heteroskedastic and the residuals of the data are correlated. After having adjusted the model to make it the standard errors robust, we continue to our second model.

4.2.2. Testing for Heteroskedasticity (Impact of GHG Emissions on Financial Performance)

Table 6: Breusch-Pagan Test for heteroskedasticity for regression of financial and stock market performance on GHG emissions

H0: Constant variance					
	ROE	ROA	EPS	Tobin's q	Expected Return
chi2(1)	0.67	0.64	0.56	0.70	0.72
Prob > chi2	0.41	0.42	0.45	0.40	0.40

After performing the heteroskedasticity test in Section 4.2.1., the same test is done on the relationship between GHG emissions and the financial performance (ROE, ROA, EPS and Tobin's q) and stock market performance (expected returns). This is also performed using a Breusch- Pagan test. In contrary to Section 4.2.1., the test does not give a significant p-value, as shown in Table 6, thus implying that the data is not heteroskedastic and the residuals of the data are not correlated. Therefore, there is no need to adjust the model to make it the standard errors robust.

4.3. Detecting Correlated Errors

Differences in residuals across industry sectors are tested. Through comparing the residuals of the different industry sectors we could observe whether the financial performance (ROE, ROA, EPS and Tobin's q) and stock market performance (expected returns) are dependent on industry type. This is tested for each measure of financial performance and stock market performance, where they are tested based on the relationship with both disclosure and GHG emissions (See Appendix 1 to Appendix 5). The data from Appendix 1 to Appendix 5 shows that the residuals did differ. This implies that different variations in values of the financial and stock market performance can be expected. Since they are factors that explain part of the variation in financial and stock market performance, they are taken into the regression.

4.4. Empirical Results and Discussion

Table 7: Impact of Carbon Disclosure on Financial Performance (adjusted with White-corrected Standard Errors)

	(1) ROE	(2) ROA	(3) EPS	(4) Tobin's q
Disclosure	0.520	0.937	-1430.111	-3.640
	(0.439)	(0.830)	(991.786)	(2.630)
Size	-0.000*	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.000)
Industry Sector				
2. Consumer Discretionary	0.010	0.188	-1885.453	-10.586
	(0.107)	(0.157)	(2232.096)	(9.299)
3. Consumer Staples	0.012	0.222*	-1318.097	-10.289
	(0.121)	(0.121)	(1945.623)	(9.199)
4. Energy	-2.471	0.138	7387.322	-8.660
	(2.274)	(0.099)	(7543.150)	(9.146)
5. Financials	0.425*	0.271*	-1362.373	-11.054
	(0.248)	(0.151)	(2015.871)	(9.223)
6. Health Care	0.115	0.285*	-1131.194	-2.780
	(0.123)	(0.162)	(1956.269)	(9.801)
7. Industrials	0.130	0.247	1023.609	-11.192
	(0.165)	(0.157)	(2652.945)	(9.307)
8. Information Technology	0.059	0.362	-1575.938	-8.567
	(0.136)	(0.245)	(1888.162)	(9.681)

9. Materials	0.133	0.175	-2270.770	-11.402
	(0.178)	(0.116)	(1888.311)	(9.167)
10. Real Estate	0.330	0.327	-1582.328	-4.879
	(0.369)	(0.319)	(1945.253)	(10.113)
11. Utilities	3.591	-25.781	-1168.884	42.370
	(3.371)	(25.621)	(1869.607)	(53.449)
Year fixed effect	Yes	Yes	Yes	Yes
Constant	1.192	0.504	13006.990	10.430
	(0.729)	(0.469)	(10450.480)	(8.754)
N	7528	7528	7528	7528
R^2	0.004	0.020	0.005	0.009
adj. R^2	0.001	0.016	0.002	0.005

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 shows the regressions on the relationship between the disclosure with the ROE, ROA, EPS and Tobin's q, as seen in Models 1, 2, 3 and 4 respectively. The table also includes control variables such as company size, industry sector (where communication services sector is being treated as a reference category) and year fixed effects. Heteroskedasticity in these models are already treated by using the robust standard errors. Furthermore, none of the coefficients for GHG emissions have a significance level of 10% or less, implying that disclosing information on their GHG emissions do not have a significant effect on either of the firm's financial performance measures.

Company size is found to be significant at 10% level on the ROE. However, it has a coefficient close to zero (coefficient of -8.12 x 10^-7; see Appendix 6), implying that a 1 billion IDR increase in company size leads to almost no change on the ROE. Apart from the relationship with ROE, company size does not have a significant effect on the other financial performance measures. This is in contrast to the presence of herd behavior from the Fransiska et al. (2018) paper, where the author suggested that a larger company size is more likely to have herding behavior amongst investors.

The industry sectors such as consumer staples, financials and healthcare sectors are found to be significant at 10% level across the different financial measures. For instance, a firm that belongs in the financial sector on average has a ROE that is 42.5% higher compared to the communication services sector. One possible interpretation for this is the fact that firms in the financial sector are more pressured to disclose climate-related performances towards their stakeholders.

Furthermore, the regression power in explaining the regressions in Table 7 is

considerably very low. This statement of a very low explanatory power originates from the fact that the adjusted R-squared, which measures the model's capability in explaining the dependent variable, only has a maximum value of 1.6%. Thus, based on the evidence showed by Table 7, it is safe to conclude that there is not enough evidence supporting that disclosing information on GHG emissions have a significant effect on the financial performance of firms.

Table 8: Impact of GHG Emissions on Financial Performance

	(1) ROE	(2) ROA	(3) EPS	(4) Tobin's q
Total Emissions	0.000	0.000	0.034	0.000
	(0.000)	(0.000)	(0.211)	(0.001)
Size	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Industry Sector				
2. Consumer Discretionary	0.522***	0.068***	327.430*	1.931*
	(0.133)	(0.022)	(181.908)	(0.999)
3. Consumer Staples	0.180*	0.075***	778.466***	4.073**
	(0.092)	(0.015)	(126.004)	(0.692)
4. Energy	-0.053	-0.015	768.362***	-0.336
	(0.095)	(0.015)	(129.823)	(0.713)
5. Financials	0.019	-0.073***	136.364	1.590
	(0.135)	(0.022)	(185.367)	(1.018)
6. Health Care	-0.007	0.063**	-57.172	3.576***
	(0.178)	(0.029)	(244.484)	(1.342)
7. Industrials	-0.259*	-0.063**	3.464	-0.351
	(0.152)	(0.025)	(208.783)	(1.146)
8. Information Technology	0.081	0.023	-137.498	34.181***
	(0.559)	(0.091)	(766.305)	(4.208)
9. Materials	-0.081	-0.012	364.480***	0.286
	(0.096)	(0.016)	(132.130)	(0.726)
10. Real Estate	-0.119	-0.046**	-49.084	-0.578
	(0.125)	(0.020)	(171.336)	(0.941)
11. Utilities	-0.062	-0.012	76.054	-0.188
	(0.186)	(0.030)	(254.811)	(1.399)
Year Fixed Effect	Yes	Yes	Yes	Yes
Constant	0.274	0.142***	-163.199	4.510***
	(0.235)	(0.038)	(322.642)	(1.772)

N	425	425	425	425
R^2	0.113	0.300	0.172	0.261
adj. R^2	0.060	0.258	0.122	0.217

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8 shows the regressions on the relationship between the GHG emissions with the ROE, ROA, EPS and Tobin's q, as seen in Models 1, 2, 3 and 4 respectively. The table also includes control variables such as company size, industry sector (where communication services sector is being treated as a reference category) and year fixed effects. Furthermore, there is no need to use robust standard errors, since the heteroskedasticity test in Section 4.2.2. shows that the model is not heteroskedastic. Similar to the results in Table 7 on disclosure, the amount of GHG emissions do not have a significant effect on the increase or decrease of any of the financial performance measures.

Furthermore, the industry sectors such as consumer discretionary, consumer staples, energy, financials, health care, industrials, information technology, materials and real estate are found to be significant at 1% level across the different financial measures. For instance, a firm that belongs in the consumer staples sector on average has a higher EPS of 778.466 IDR compared to the communication services sector, as seen in Model 3 of Table 8.

The regression power in explaining the regressions in Table 8 is considerably sufficient. This statement of a sufficient explanatory power originates from the fact that the adjusted R-squared has a maximum value of 25.8%, seen in Model 2. However, the regression on the effect on ROE has a weak explanatory power with the adjusted R-squared of 6.0%, as seen in Model 1. Thus, based on the evidence showed by Table 8, it is safe to conclude that there is not enough evidence supporting that the amount of GHG emissions have a significant impact on the financial performance of firms.

The results in Table 7 and Table 8 show that there is not enough evidence supporting that either disclosing information on GHG emissions or the amount of GHG emissions have a significant effect on the financial performance of firms. Although these relationships are known to be significant based on existing literatures of this topic on developed economies, the results in Table 7 and Table 8 might give an implication of the characteristics of Indonesian stakeholders over the past 11 years.

Firstly, the weak explanatory power of the regressions in Table 7 implies that there may have been many unobserved factors that contribute to the financial performance of firms, and that disclosing information on GHG emissions alone is not significant enough to affect such performance measures. Another possible interpretation could be that the motives on why firms

in Indonesia disclose information on GHG emissions may have nothing to do with their efforts on improving their financial performances. The results seen in Table 8 show that there is not enough evidence showing that Indonesian firms financially benefit from minimizing their GHG emissions. Furthermore, these results are in line with our findings that only 5.6% of the full sample size disclosed information on their GHG emissions, implying that a large portion of Indonesian firms do not set high priorities in optimizing their GHG performance.

Table 9: Impact of Carbon Disclosure on Stock Market Performance (adjusted with White-corrected Standard Errors)

	(1) Expected Return	(2) Expected Return
Disclosure (1), Total Emissions (2)	-0.030***	0.000
	(0.005)	(0.001)
Size	-0.000*	0.000
	(0.000)	(0.000)
Industry Sector		
2. Consumer Discretionary	-0.005	-0.004
	(0.005)	(0.017)
3. Consumer Staples	-0.007	0.013
	(0.005)	(0.012)
4. Energy	-0.014**	-0.010
	(0.006)	(0.013)
5. Financials	-0.007	-0.033*
	(0.005)	(0.020)
6. Health Care	-0.001	0.014
	(0.009)	(0.024)
7. Industrials	-0.017***	-0.021
	(0.005)	(0.018)
8. Information Technology	-0.006	0.014
	(0.008)	(0.061)
9. Materials	-0.016***	-0.016
	(0.005)	(0.015)
10. Real Estate	-0.011*	-0.023
	(0.006)	(0.014)
11. Utilities	-0.005	-0.043*
	(0.014)	(0.024)
Year Fixed Effects	Yes	Yes

Constant	-0.063***	-0.124***
	(0.007)	(0.013)
N	4076	294
R^2	0.455	0.816
adj. R^2	0.453	0.803

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9 shows the regressions on the relationship of disclosure and GHG emissions with the expected stock returns, as seen in Models 1 and 2 respectively. The table also includes control variables such as company size, industry sector (where communication services sector is being treated as a reference category) and year fixed effects. Furthermore, the regression in Model 1 makes use of robust standard errors to treat for heteroskedasticity, while Model 2 did not use robust standard errors. This can be seen in the heteroskedasticity test in Section 4.2.1. and Section 4.2.2..

One main observation can be found in Model 1, wherein disclosing information on GHG emissions tend to be significant at a 1% level. This implies that firms that disclose information on GHG emissions will have, on average, a decrease in expected stock return by 3.01% compared to firms that do not disclose information on GHG emissions. Furthermore, the regression power in explaining the regression tends to be sufficient, with the adjusted R-squared of 45.3%. The industry sectors such as energy, industrials and materials on average tend to have a negative significant effect on the expected stock returns at 5%, 1% and 1% significance level respectively.

On the other hand, the amount of GHG emissions does not have a significant effect on the stock returns, as seen in Model 2. Not only that, most of the variables included in Model 2 do not have a significant effect on on the expected stock returns. However, the regression power in explaining the regression also tends to be sufficient, with the adjusted R-squared of 80.3%.

The results in Table 9 show that disclosing information on GHG emissions does have a significant negative effect on the expected stock returns of firms (as seen in Model 1), however do not show enough evidence when regressing the amount of GHG emissions (as seen in Model 2). From these results, it is possible to apply the stakeholder theory for two possible interpretations:

(1) The negative coefficient of *disclosure* in Model 1 is in contrast to the stakeholder theory. The stakeholder theory under this context assumes that the stakeholders (specifically shareholders) would react positively when firms show their efforts to maximize their GHG performance. Therefore, the stakeholder theory should expect the disclosure of such information to have a significant positive effect on the expected stock returns. Therefore, this

interpretation gives room for further research on what considerations Indonesian investors have to go through when making investment decisions.

(2) The negative coefficient of *disclosure* in Model 1 may imply that the the shareholders of Indonesian firms do not necessarily seek for the transparency of these firms' GHG performance. Given that investment decisions of Indonesian investors are influenced by the financial information of firms, as described by Listyarti et al. (2014), these shareholders and potential investors may anticipate the decline of these firms' financial performance in the future, and would therefore choose to not invest on their shares, therefore further verifying the rational behavior of Indonesian investors. Furthermore, the results from Model 2 imply that more research needs to be done on how stakeholders respond to the amount of GHG Indonesian firms emit.

Furthermore, these results may also imply that the Indonesian market still has an ambiguous perception towards issues regarding the GHG emissions of firms, and therefore the societal expectations and norms in the Indonesian market is not concrete enough for the legitimacy theory to be implemented.

Thus, based on the evidence showed by Table 9, it is safe to conclude that disclosing information on GHG emissions and the amount of GHG emissions does have a significant effect on the expected stock returns, while the amount of GHG emissions does not have a significant effect on the expected stock returns of firms.

5. Conclusion and Recommendations

The growing concern on the GHG emissions of firms has led to the interest to explore whether the same phenomenon can be applied in Indonesia; a growing economy where the regulatory framework on issues pertaining to the environment is still relatively loose when compared to developed economies.

Overall, the results shown in this paper suggests that there is not enough evidence indicating that Indonesian firms financially benefit from having better GHG performance. This is seen in how neither the results on the disclosure of GHG emissions data or the amount of GHG emissions provide enough evidence of a more profitable outcome for Indonesian firms. Furthermore, the disclosure of GHG emissions data has led to lower expected stock returns for Indonesian firms. However, this relationship is not in line with any of the existing literatures.

Based on the different hypotheses, the results in this paper show that there is not enough evidence to prove that firms that disclose information on their GHG performance have a stronger financial performance than firms that do not disclose. Therefore, we cannot prove *Hypothesis 1a* to be true. However, this paper has found that firms that disclose information on their GHG performance have a worse stock market performance than firms that do not disclose, and therefore proving *Hypothesis 1b* not to be true. Furthermore, the results in this paper also show that there is not enough evidence to prove that the amount of GHG emissions leads to a significantly stronger financial performance, and therefore *Hypothesis 2a* can be true. This same interpretation can be applied for the stock market performance, and therefore Hypothesis 2b can also be true.

The implications of this study may sum up the behavior of the stakeholders of Indonesian firms for the past years. This may explain why the research pertaining to the GHG emissions of Indonesian firms and its effects on their profitability have not been sufficiently explored in existing literatures. This is reasonable given that only 5.6% of the publicly listed Indonesian firms disclosed information on GHG emissions, which may be rooted by the fact that the disclosure of GHG emissions is not mandated by the government in Indonesia. Therefore, it could be interesting to further research on what can be done to encourage firms to disclose such information. Perhaps, one possible research can focus on whether regulators can achieve environmental objectives by exploiting the profit-maximizing behavior of firms.

One could say that if better GHG performance does not lead to a more profitable outcome, then new regulations should be made in order to incentivize firms to disclose information on their GHG performance and to take efforts to minimize GHG emissions.

However, we cannot assume that mandated GHG performance is a priority for the Indonesian government for the years to come.

The scope of this research is limited to one of the ESG (Environmental, Social and Corporate Governance) criteria, which focuses on the environmental aspect of the behavior of Indonesian firms. A research that focuses on the other measures of the ESG criteria can provide a more in depth insight on the characteristics of Indonesian stakeholders, and therefore would give a more concrete implication on what policies should be implemented to fulfill Indonesia's goals for the years to come. Furthermore, replicating this study in another developing country with mandated GHG disclosure would provide a clearer picture on how stakeholders react towards the behavior of firms, and can therefore be representative to how stakeholders of Indonesian firms would react if GHG disclosure is mandatory. Apart from that, replicating this research outside of the economic context (i.e. public satisfaction, corporate legitimacy, etc.) enables us to further explore the non-monetary aspect of stakeholder's priorities and expectations towards Indonesian firms.

Overall, this study has opened room for more research on the current behavior of Indonesian firms and its (external) stakeholders. This can therefore help regulators make decisions with this information to achieve their (environmental) objectives, and help Indonesian firms strategize on their behaviors accordingly to maximize their firm performance.

6. References

Alvarez, I. G., Segura, L., & Ferrero, J. M. (2015). Carbon emission reduction: the impact on the financial and operational performance of international companies. *Journal of Cleaner Production 103*. 149-159.

Brouwers, R., Schoubben, F., & Hulle, C. V. (2018). The influence of carbon cost pass through on the link between carbon emission and corporate financial performance in the context of the European Union Emission Trading Scheme. *Business Strategy and the Environment. 27*(8), 1422-1436. doi: 10.1002/bse.2193

Blackman, A., Afsah, S., & Ratunanda, D. (2004). How Do Public Disclosure Pollution Control Programs Work? Evidence from Indonesia. *Human Ecology Review, 11*(3), 235–246. http://www.jstor.org/stable/24707717

Desai, R., Raval, A., Baser, N. & Desai, J. (2021). Impact of carbon emission on financial performance: empirical evidence from India. *South Asian Journal of Business Studies*. https://doi.org/10.1108/SAJBS-10-2020-0384

Dowling, J., & Pfeffer, J. (1975). Organizational Legitimacy: Social Values and Organizational Behavior. *The Pacific Sociological Review*, *18*(1), 122–136. https://doi.org/10.2307/1388226

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*(1), 3–56. doi: 10.1016/0304-405x(93)90023-5

Fransiska, M., Sumani, Willy, & Pangestu, S. (2018). Herding Behavior in Indonesian Investors. *International Research Journal of Business Studies*. 129-143. https://doi.org/10.21632/irjbs

In, S. Y., Park, K. Y., & Monk, A. (2017). Is "Being Green" Rewarded in the Market? An Empirical Investigation of Decarbonization Risk and Stock Returns. *Stanford Global Project Center Working Paper*, 46-48.

Kumar, P. & Firoz, M. (2018). Impact of carbon emissions on cost of debt-evidence from India. *Managerial Finance, 44*(12), 1401-1417. https://doi.org/10.1108/MF-03-2018-0108

Lee, S.Y., Park, Y.S. and Klassen, R.D. (2013). Market responses to firms' voluntary climate change information disclosure and carbon communication. *Corporate Social Responsibility and Environmental Management*, *22*(1), 1-12.

Lewandowski (2017). Corporate Carbon and Financial Performance: The Role of Emission Reductions. *Business Strategy and the Environment, 26*(8), 1196-1211. doi: 10.1002/bse.1978

Listyarti, I. & Suryani, T. (2014). Determinant factors of investors' behavior in investment decision in Indonesian capital markets. *Journal of Economics, Business, and Accountancy Ventura*, *17*(1), 45-54.

Miah, M.D., Hasan, R., & Usman, M. (2021). Carbon Emissions and Firm Performance: Evidence from Financial and Non-Financial Firms from Selected Emerging Economies. *Sustainability, 13*(23):13281. https://doi.org/10.3390/su132313281

Nurdiawansyah, N., Lindrianasari, L., & Komalasari, A. (2018). Carbon Emission Issues in Indonesia. *Review of Integrative Business and Economics Research*, *7*(3), 20-33.

Ranganathan, J., Corbier, L., Bhatia, P., Schmitz, S., Gage, P., & Oren, K. (2004). *The Greenhouse Gas Protocol*. World Business Council for Sustainable Development & World Resources Institute.

Ruf, B.M., Muralidhar, K., Brown, R.M. et al. An Empirical Investigation of the Relationship Between Change in Corporate Social Performance and Financial Performance: A Stakeholder Theory Perspective. *Journal of Business Ethics 32*, 143–156 (2001). https://doi.org/10.1023/A:1010786912118

Sarumpaet (2005). The Relationship between Environmental Performance and Financial Performance of Indonesian Companies. *Jurnal Akutansi dan Keuangan, 7*(2), 89-98. doi: https://doi.org/10.9744/jak.7.2.pp.%2089-98

Solikah, B., Wahyudin, A., & Subowo (2020). Carbon emissions of manufacturing companies in Indonesia stock exchange: a sustainable business perspective. *Journal of Physics: Conference Series*. doi: 10.1088/1742-6596/1567/4/042086

Torres, M. M. & Kanungo, P. (2003). Indonesia's program for pollution control, evaluation, and rating (PROPER) (English). *Empowerment case studies Washington, D.C. : World Bank Group*.

Trinks, A., Mulder, M., & Scholtens, B. (2020). An Efficiency Perspective on Carbon Emissions and Financial Performance. *Ecological Economics 175*.

7. Appendix

Appendix 1: Detecting Correlated Errors across Industry Sectors (ROE)

Disclosure

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	.05583146	1.6327399	430
Consumer Discretionary	.04253158	.71556097	1057
Consumer Staples	.05685605	2.311048	907
Energy	-2.4261387	56.890655	609
Financials	.41553633	7.1040975	1160
Health Care	.14558983	.86699462	230
Industrials	.15490806	4.5894194	1221
Information Technology	.0919173	1.1385983	196
Materials	.17219133	4.5528252	900
Real Estate	.37131998	9.8590306	764
Utilities	3.6233263	25.007345	54
Total	3.024e-09	17.055653	7528

Total Emissions

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	-.00812437	.21147756	73
Consumer Discretionary	.50133233	1.8698082	23
Consumer Staples	.16971465	.41445634	71
Energy	-.06304876	.62458912	64
Financials	-.05560239	.0675469	68
Health Care	-.01416745	.0357621	11
Industrials	-.2804312	.71008379	16
Information Technology	.06134189	0	1
Materials	-.10018853	.08694144	60
Real Estate	-.14715121	.13708345	27
Utilities	-.0550388	.14036655	11
Total	1.471e-09	.56745513	425

Appendix 2: Detecting Correlated Errors across Industry Sectors (ROA)

Disclosure

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	.05225471	1.6151032	430
Consumer Discretionary	.13319182	.58091408	1057
Consumer Staples	.20108811	.12530418	907
Energy	.15629931	.20064178	609
Financials	.23042411	2.1508278	1160
Health Care	.21998247	.08613775	230
Industrials	.18758405	.33178829	1221
Information Technology	.19274274	.19550657	196
Materials	.16618171	.18272931	900
Real Estate	.28314922	7.8423628	764
Utilities	-25.767067	190.08049	54
Total	1.936e-09	16.321105	7528

Total Emissions

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	.00045883	.08268303	73
Consumer Discretionary	.07111333	.14100865	23
Consumer Staples	.07955071	.1227402	71
Energy	-.00825138	.13021399	64
Financials	-.06420091	.00776373	68
Health Care	.06761166	.02365989	11
Industrials	-.0686436	.03138499	16
Information Technology	.01505564	0	1
Materials	-.00876037	.06829715	60
Real Estate	-.05372499	.05812511	27
Utilities	-.00979463	.07273133	11
Total	-6.766e-11	.10362031	425

Appendix 3: Detecting Correlated Errors across Industry Sectors (EPS)

Disclosure

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	449.47283	38433.034	430
Consumer Discretionary	-1438.508	37757.496	1057
Consumer Staples	-979.1399	15768.1	907
Energy	7999.6247	184174.21	609
Financials	-791.51988	19375.266	1160
Health Care	-823.62774	6976.3557	230
Industrials	1257.1436	63651.873	1221
Information Technology	-1962.1763	206.59734	196
Materials	-1838.3906	524.65945	900
Real Estate	-1252.2832	12444.995	764
Utilities	-1628.7861	706.80091	54
Total	-.00001266	61582.585	7528

Total Emissions

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	-360.06604	209.78662	73
Consumer Discretionary	-23.574834	242.63179	23
Consumer Staples	419.65629	1202.7269	71
Energy	414.23873	1312.5914	64
Financials	-80.466239	265.13255	68
Health Care	-416.74596	10.271381	11
Industrials	-345.43255	214.09778	16
Information Technology	-403.79797	0	1
Materials	7.7973036	451.6921	60
Real Estate	-415.70043	66.73518	27
Utilities	-248.83013	160.52945	11
Total	-4.454e-07	805.07068	425

Appendix 4: Detecting Correlated Errors across Industry Sectors (Tobin's q)

Disclosure

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	8.4927121	186.44962	430
Consumer Discretionary	-1.6848327	9.2177662	1057
Consumer Staples	-1.523755	4.4525338	907
Energy	-.02449594	26.537282	609
Financials	-2.2178509	5.5945057	1160
Health Care	6.1792525	46.002681	230
Industrials	-2.3087694	8.1829082	1221
Information Technology	.72776244	16.578418	196
Materials	-2.688079	2.9793634	900
Real Estate	3.9611407	111.60951	764
Utilities	50.866114	391.49932	54
Total	-1.605e-08	67.166476	7528

Total Emissions

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	-1.2029444	1.0617282	73
Consumer Discretionary	.84559233	4.0657769	23
Consumer Staples	2.9524785	6.6388508	71
Energy	-1.4001663	1.2345859	64
Financials	.55850549	7.0177329	68
Health Care	2.4483222	1.6257935	11
Industrials	-1.7730799	.62048756	16
Information Technology	31.908415	0	1
Materials	-.86509238	1.4249696	60
Real Estate	-2.0153167	.37326264	27
Utilities	-1.2526346	1.1416292	11
Total	1.396e-09	4.6804165	425

Appendix 5: Detecting Correlated Errors across Industry Sectors (Expected Returns)

Disclosure

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	.0098854	.08977362	234
Consumer Discretionary	.00518916	.10270852	575
Consumer Staples	.00372786	.09682464	480
Energy	-.00246765	.10915313	331
Financials	.00203212	.1025673	650
Health Care	.00718122	.11159517	115
Industrials	-.00811827	.1063864	671
Information Technology	-.00139378	.08957721	104
Materials	-.00564866	.10745463	471
Real Estate	-.0008516	.12871771	417
Utilities	.00618406	.08970229	31
Total	1.001e-09	.10584833	4079

Total Emissions

GICS Sector Name	Summary of Residuals		
	Mean	SD	Frequency
Communication Services	.00361033	.10875119	53
Consumer Discretionary	.00032823	.15554799	16
Consumer Staples	.02272204	.10613589	48
Energy	.00383269	.10945648	41
Financials	-.00928699	.1695213	40
Health Care	.01923705	.11614263	7
Industrials	-.00489644	.16855216	14
Information Technology	.01369528	0	1
Materials	-.0118186	.11369789	41
Real Estate	-.01615093	.20453097	26
Utilities	-.03546216	.16341016	7
Total	4.409e-10	.13493397	294

Appendix 6: Impact of Carbon Disclosure on Financial Performance (adjusted with White-corrected Standard Errors)

	(1) roe	(2) roa	(3) eps	(4) tobins_q
disclosure	0.520	0.937	-1430.1	-3.640
	(0.439)	(0.830)	(991.8)	(2.630)
size	-8.12e-7*	-3.50e-7	4.20e-4	6.03e-7
	(4.28e-7)	(3.07e-7)	(1.41e-3)	(1.64e-6)
1. Communication Services	0	0	0	0
	(.)	(.)	(.)	(.)
2. Consumer Discretionary	0.00956	0.188	-1885.5	-10.59
	(0.107)	(0.157)	(2232.1)	(9.299)
3. Consumer Staples	0.0121	0.222*	-1318.1	-10.29
	(0.121)	(0.121)	(1945.6)	(9.199)
4. Energy	-2.471	0.138	7387.3	-8.660
	(2.274)	(0.0987)	(7543.2)	(9.146)
5. Financials	0.425*	0.271*	-1362.4	-11.05
	(0.248)	(0.151)	(2015.9)	(9.223)
6. Health Care	0.115	0.285*	-1131.2	-2.780
	(0.123)	(0.162)	(1956.3)	(9.801)
7. Industrials	0.130	0.247	1023.6	-11.19
	(0.165)	(0.157)	(2652.9)	(9.307)
8. Information Technology	0.0591	0.362	-1575.9	-8.567
	(0.136)	(0.245)	(1888.2)	(9.681)
9. Materials	0.133	0.175	-2270.8	-11.40
	(0.178)	(0.116)	(1888.3)	(9.167)
10. Real Estate	0.330	0.327	-1582.3	-4.879
	(0.369)	(0.319)	(1945.3)	(10.11)
11. Utilities	3.591	-25.78	-1168.9	42.37
	(3.371)	(25.62)	(1869.6)	(53.45)
2009.year	0	0	0	0

	(.)	(.)	(.)	(.)
2010.year	-0.864	-0.580	-6875.9	0.425
	(0.754)	(0.493)	(11250.1)	(0.388)
2011.year	-0.793	-0.830	-6584.2	2.478
	(0.765)	(0.550)	(11357.3)	(2.170)
2012.year	-0.666	-0.572	-6177.8	6.724
	(0.832)	(0.492)	(11555.0)	(5.767)
2013.year	-3.870	-0.572	-12423.4	2.177*
	(2.934)	(0.496)	(10825.2)	(1.184)
2014.year	-1.024	-0.538	-11885.6	1.786
	(0.743)	(0.504)	(10820.2)	(1.112)
2015.year	-1.075	-0.611	-12503.0	1.158
	(0.743)	(0.500)	(10775.2)	(0.853)
2016.year	-1.071	-0.515	-12785.5	0.392
	(0.747)	(0.516)	(10739.6)	(0.588)
2017.year	-1.466*	-0.531	-12241.9	2.229
	(0.867)	(0.510)	(10678.6)	(1.722)
2018.year	-0.656	-0.546	-12352.8	0.548
	(0.811)	(0.506)	(10678.8)	(0.442)
2019.year	-0.970	-0.558	-12363.2*	0.941
	(0.771)	(0.505)	(10669.7)	(0.544)
2020.year	-1.251*	-0.594	-12346.8	1.699
	(0.748)	(0.504)	(10670.2)	(1.062)
2021.year	-1.238*	-2.623	-12314.8	11.35
	(0.750)	(1.955)	(10687.1)	(6.912)
_cons	1.192	0.504	13007.0	10.43
	(0.729)	(0.469)	(10450.5)	(8.754)
N	7528	7528	7528	7528
R^2	0.004	0.020	0.005	0.009
adj. R^2	0.001	0.016	0.002	0.005

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix 7: Impact of GHG Emissions on Financial Performance

	(1) roe	(2) roa	(3) eps	(4) tobins_q
total_emissions	1.10e-4	3.30e-5	3.42e-2	4.71e-4
	(1.54e-4)	(2.50e-5)	(0.211)	(1.16e-5)
size	-1.15e-7	-3.63e-9	2.50e-4	-2.41e-7
	(1.60e-7)	(2.60e-9)	(2.19e-4)	(1.20e-6)
1. Communication Services	0	0	0	0
	(.)	(.)	(.)	(.)
2. Consumer Discretionary	0.522***	0.0681***	327.4*	1.931*
	(0.133)	(0.0216)	(181.9)	(0.999)
3. Consumer Staples	0.180*	0.0754***	778.5***	4.073**
	(0.0919)	(0.0149)	(126.0)	(0.692)
4. Energy	-0.0527	-0.0148	768.4***	-0.336
	(0.0947)	(0.0154)	(129.8)	(0.713)
5. Financials	0.0192	-0.0725***	136.4	1.590
	(0.135)	(0.0220)	(185.4)	(1.018)
6. Health Care	-0.00740	0.0629**	-57.17	3.576***
	(0.178)	(0.0290)	(244.5)	(1.342)
7. Industrials	-0.259*	-0.0631**	3.464	-0.351
	(0.152)	(0.0248)	(208.8)	(1.146)
8. Information Technology	0.0811	0.0231	-137.5	34.18***
	(0.559)	(0.0909)	(766.3)	(4.208)
9. Materials	-0.0806	-0.0119	364.5***	0.286
	(0.0964)	(0.0157)	(132.1)	(0.726)
10. Real Estate	-0.119	-0.0458**	-49.08	-0.578
	(0.125)	(0.0203)	(171.3)	(0.941)
11. Utilities	-0.0619	-0.0124	76.05	-0.188
	(0.186)	(0.0302)	(254.8)	(1.399)
2009.year	0	0	0	0
	(.)	(.)	(.)	(.)

2010.year	0.00402	0.0105	210.7	-0.407
	(0.270)	(0.0439)	(370.1)	(2.032)
2011.year	-0.00699	-0.000105	371.9	-1.990
	(0.253)	(0.0411)	(346.6)	(1.903)
2012.year	-0.224	-0.0234	325.2	-2.026
	(0.254)	(0.0413)	(348.0)	(1.911)
2013.year	-0.0294	-0.0477	232.5	-2.131
	(0.251)	(0.0408)	(343.6)	(1.887)
2014.year	0.188	-0.0451	258.3	-2.011
	(0.247)	(0.0402)	(339.2)	(1.862)
2015.year	-0.0395	-0.0773*	143.6	-2.781
	(0.247)	(0.0401)	(338.2)	(1.857)
2016.year	-0.0608	-0.0493	216.7	-2.781
	(0.246)	(0.0400)	(336.8)	(1.850)
2017.year	-0.0622	-0.0494	288.6	-2.378
	(0.245)	(0.0398)	(335.8)	(1.844)
2018.year	-0.0772	-0.0541	338.7	-2.898
	(0.245)	(0.0398)	(335.4)	(1.842)
2019.year	-0.0832	-0.0651	289.7	-3.035
	(0.245)	(0.0398)	(335.3)	(1.841)
2020.year	-0.237	-0.0982**	94.67	-2.943
	(0.244)	(0.0397)	(334.3)	(1.836)
2021.year	-0.0785	-0.0651	360.9	-3.759***
	(0.243)	(0.0396)	(333.6)	(1.832)
_cons	0.274	0.142***	-163.2	4.510***
	(0.235)	(0.0383)	(322.6)	(1.772)
N	425	425	425	425
R^2	0.113	0.300	0.172	0.261
adj. R^2	0.060	0.258	0.122	0.217

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix 8: Impact of Carbon Disclosure on Stock Market Performance (adjusted with White-corrected Standard Errors)

	(1) expected_return
disclosure	-0.0301***
	(0.00538)
size	-2.90e-8*
	(1.56e-8)
1. Communication Services	0
	(.)
2. Consumer Discretionary	-0.00534
	(0.00548)
3. Consumer Staples	-0.00661
	(0.00512)
4. Energy	-0.0136**
	(0.00605)
5. Financials	-0.00741
	(0.00538)
6. Health Care	-0.00145
	(0.00917)
7. Industrials	-0.0173***
	(0.00529)
8. Information Technology	-0.00578
	(0.00787)
9. Materials	-0.0157***
	(0.00531)
10. Real Estate	-0.0110*
	(0.00635)
11. Utilities	-0.00543
	(0.0141)
2015.year	0
	(.)
2016.year	0.191***
	(0.00555)

2017.year	0.241***
	(0.00732)
2018.year	0.0787***
	(0.00675)
2019.year	0.126***
	(0.00546)
2020.year	0.0564***
	(0.00622)
2021.year	0.111***
	(0.00549)
_cons	-0.0634***
	(0.00673)
N	4076
R^2	0.455
adj. R^2	0.453

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix 9: Impact of GHG Emissions on Stock Market Performance (adjusted with White-corrected Standard Errors)

	(1)
	expected_return
total_emissions	4.26e-6
	(8.76e-4)
size	2.22e-8
	(1.99e-8)
1. Communication Services	0
	(.)
2. Consumer Discretionary	-0.00422
	(0.0173)
3. Consumer Staples	0.0131
	(0.0120)
4. Energy	-0.00960
	(0.0127)
5. Financials	-0.0325*

	(0.0195)
6. Health Care	0.0140
	(0.0241)
7. Industrials	-0.0211
	(0.0180)
8. Information Technology	0.0142
	(0.0610)
9. Materials	-0.0161
	(0.0146)
10. Real Estate	-0.0226
	(0.0144)
11. Utilities	-0.0426*
	(0.0241)
2015.year	0
	(.)
2016.year	0.262***
	(0.0141)
2017.year	0.364***
	(0.0139)
2018.year	0.0444***
	(0.0138)
2019.year	0.153***
	(0.0137)
2020.year	0.0202
	(0.0135)
2021.year	0.134***
	(0.0134)
_cons	-0.124***
	(0.0125)
N	294
R^2	0.816
adj. R^2	0.803

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$