Air Pollution, Regulations on Emission and Firms' Social Responsibility

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Abstract

This paper examines whether firms update their strategy in emission when air pollution is severe. Considering high PM 2.5 as severe air pollution across 65 countries, I show that firms from countries with severe air pollution have low emission score, suggesting that they put less effort in reducing emission. This is because if they improve emission strategy, firm performance deteriorates. However, such relationship disappears when the government's environmental stringency is strong. This paper concludes with analysis on the factors which can mediate the negative impact of air pollution on firms' emission strategies.

JEL classification: *G32, G38, D22, Q53*

Keywords: *Air Pollution, Emission, Firm Performance, Environmental Stringency*

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1. Introduction

Our world faced air pollution problems well before industrialization. Jacobson (2012) mentions that "we saw the harmful effects of air pollution even in Roman times" and Romans even try to solve the problem by creating an act for clean air in 535 by Emperor Justinian. In recent years, air pollution stems mainly from car emissions, factories, and energy production. While regulating industry's emission will not entirely remove air pollution, effective policy which encourages firms to put in effort to use clean technologies thereby reducing emissions is essential to obtain clean air globally.

Not every firm has the same motivation to improve air quality. Some managers and boards value social responsibility relatively more due to their gender diversity (Borghesi et al., 2014; Cronqvist and Yu, 2017; McGuinness et al., 2017; Hegde and Mishra, 2019), age (Borghesi et al., 2014), confidence level (McCarthy et al., 2017), employee friendliness (Landier et al., 2017), political stance (Di Giuli and Kostovertsky, 2014; Borghesi et al., 2014) and CEO compensation (Gillian et al., 2010; Jian and Lee, 2015; Ferrell et al., 2016; Borghesi et al., 2014; Masulis and Reza, 2015; Ikram et al., 2019). Not only that, but their motivation may also stem from stakeholders' pressure (Kassinis and Vafeas, 2006; Perez-Batres et al., 2012; Reinecke and Ansari, 2015; Fu et al., 2019) and institutional background (Agle et al., 1999; Campbell, 2007; Ding et al., 2014; Fineman and Clarke, 1996; Hart and Ahuja, 1996; Sharma and Henriques, 2005; Barnett, 2012; Darnall and Carmin, 2005; Lange and Washburn, 2012; Surroca et al., 2013).

This paper examines the effectiveness of institutional-level environmental stringency on firms' reduction on emission for both better air quality and firm performance. First, I view air pollution as the continuing lack of control from government which undermines the perceptual salience of environmental issues (Barnett, 2012; Bundy et al., 2013; Gomulya and Mishina, 2017). As a result, there are no effective regulations on air pollution and even if there are, firms will not consider air pollution as a top priority issue (Tran et al., 2023). Consistent with this view, I empirically show that firms in countries with severe air pollution put less effort in reducing emissions. Then I examine whether environmental stringency mitigates such negative impact. The result shows that governments' strict policy on emission does not encourage firms to reduce their emissions of pollutants but instead discourages even further to improve their emission strategy. Overall results suggest that general perception on improving air quality in society is the driving factor for firms to reduce their emissions.

Since government's environmental policy exacerbates firms' motivation to reduce their emissions, should it stop making policy on environmental protection? When the Environmental Stringency Index (ESI) at country level alone is regressed to emission score of firms, there is no effect from ESI. However, when interaction terms of air pollution and ESI are included, ESI has a positive and statistically significant coefficient, and the coefficient is much bigger than that of negative coefficient of interaction term. This indicates that when the air pollution is severe, firms behave inconsiderately towards the emission but strict regulations at institutional level mitigate such behavior.

Using the firm performance, I further show that environmental policy at institutional level is critical to encourage firms' emissions reduction. There are mixed findings in the impact of social responsibility of firms on firm performance but around 90% of previous studies show a nonnegative relationship between corporate environmental performance and firm performance (Friede et al., 2015). While previous studies mainly focus on one country for their analysis, this paper adds country environmental factors to examine in which institutional setting that firm performance can be positive for socially responsible firms. By regressing emission score on Tobin's Q, I find that firms which try to reduce emissions have lower firm performance, consistent with Krueger (2015) which shows that managers choose to be socially responsible at shareholders' expense. However, if the government has strict regulations and supports environmentally friendly strategy, socially responsible firms perform relatively better than non-socially responsible firms. This further supports my finding that government action is essential to motivate firms to reduce emissions.

In the additional analysis, I show that my main findings are driven by high technology industry which suggests that government should monitor or regulate emissions more on this industry while energy transportation industry seems to self-regulate and improves its emission strategies when the air pollution is severe. Furthermore, the government should support firms which improve their innovation strategy when country is facing air pollution instead of simply checking firms spending on research and development since high spending on research and development firms do not react to severe air pollution.

I conclude this paper with analysis on how firms which have greater exposure to the public response to air pollution in their emission strategy. Servaes ad Tamayo (2013) and Albuquerque et al. (2019) find that firms who spend more on advertisement benefits from being socially responsible. Similarly, I find that firms which are more exposed to the public through the media coverage, react more to the air pollution and improve their emission strategy. In addition, firms with established good image on corporate social responsibility react more to air pollution as well. Lastly, I show that institutional ownership does not influence firms' emission strategy when the air pollution is severe. Overall results indicate that government is not the only one to rely on to monitor and influence firms to be more socially responsible.

This paper contributes to literature in several ways. First, I empirically show that at international level, firms do not improve their emission strategies in countries with severe air pollution since being socially responsible leads to poorer firm performance. This is consistent with previous literature which finds that firm's participation in certain social issues (e.g. donations, cleaner energy) is associated with higher agency costs and lower shareholder value (Hillman and Keim, 2001; Brown, Helland, and Smith, 2006; Di Giuli and Kostovetsky, 2014;

Masulis and Reza, 2015). Second, I empirically show that firms from high environmental stringency benefit more by being socially responsible. This proposes the underlying mechanism that government can act to encourage firms to reduce emissions for better air quality and firm performance. Lastly, I also introduce some mediators who can influence firms to be more socially responsible when there is sever air pollution.

The remainder of this paper is structured as follows. Section 2 discusses the data and sample. Section 3 presents the main findings of the paper and Section 4 provides results on additional tests. Section 5 concludes the paper.

2. Data and Sample

2.1. Sample

My initial sample comprises all firms that are available in the Thomson-Reuters Refinitiv Database for the period of 2002 to 2019. From Refinitiv, emission scores for each firm are collected. Next, I gather air quality data from World Health Organization (WHO) which is available from 2010 to 2019. WHO provides air quality data on urban, city, rural and towns and I use air quality data on urban areas since most firms are in urban areas which have the most severe air pollution in the country.

Then, I obtain firm-level accounting data from Thomson-Reuters Worldscope and Datastream, and require firms not to have any missing information for firm-level control variables. Country-level variables are collected from sources such as World Bank and OECD. For example, measurement on government environmental policy is proxied by Environmental Stringency Index which is available from 2012 to 2019 from OECD library. Finally, I also remove financial firms (SIC Code 6000-6999) and my final sample includes 27,496 firm-year observations (9,684 firms) from 65 countries during the period from 2012 to 2019.

2.2. Variable construction

2.2.1. Emission Score

To measure the effort of firms reducing emission at firm level, I use emission performance score, *Emission_Score*, available from *Refitinitiv* database. Thomson-Reuters define this variable as “a company’s commitment and effectiveness towards reducing environmental emission in the production and operational processes”. This variable is already normalized by the source, and it ranges from 0 to 100. A higher score indicates more effort from firms to reduce and lower the mission from their operation.

2.2.2. Air Pollution

While there are many sources of air quality to be used, such as World Air Quality Index Project and World Bank, I utilize data from WHO as it keeps the most reliable and consistent measurement on PM2.5; it stands for fine particles, with 2.5 μm in diameter and smaller, found mostly in smoke or gases released by fires, industrial activities and automobile emissions. WHO defines it as the most dangerous pollution for people’s health and society and it best represents air pollution stemming from industries. The annual average of PM2.5 of urban areas for each country is logged to create a variable, *Air_Pollution*.

2.2.3. Controls

Firm-specific financial information on international firms is acquired from *WorldScope* and *Datastream*. Following previous literature such as Campbell (2007) and Darnall et al. (2010), I control for firm-specific characteristic variables such as the natural logarithm value of a firm’s market capitalization (*Size*); return on equity (*ROE*); ratio of total debt (*Leverage*); annual growth of sales (*Investment_Opportunity*); the amount spent of capital expenditure scaled by total assets (*Capital_Expenditure*); the amount spent on research and development scaled by net sales (*Research and Development*).

Country-level control variables are also included. Environmental Stringency Index from OECD library is defined as “the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour”. The log value of the

Environmental Stringency Index of each country is used to compose *Environmental Stringency* variable. The log value of GDP per capita for a country (*GDP_Capita*) and the log value of CO2 level per capita (*CO2*) are collected from World Bank.

2.3. Summary statistics

Table 1 reports the summary statistics for the independent and dependent variables. First, our dependent variable, *Emission_Score*, has a mean of 0.379 and a median of 0.339. This indicates that, internationally, the majority of firms still are not seriously considering emission strategy for their operation. The most interesting summary statistic of control variables is on Research & Development. 75^{th} Percentile is 0 and this indicates that the majority of firms do not spend much on research and development globally.

<Insert Table 1 here>

3. Main Results

3.1. Baseline findings

To investigate whether firm's emission strategy react to air pollution, we use the following equation:

$$Emission\_Score_{i,c,t} = \alpha + \beta_1\ Air\_Pollution_{c,t} + \beta_2 X_{i,c,t} + \Phi_i + \theta_t + \varepsilon_{i,t}$$

where the indices i, c and t correspond to firm, country and year, respectively. $Emission\_Score_{i,c,t}$ represents the firms effort to reduce emission. $Air\_Pollution_{c,t}$ measures annual average of PM2.5 of urban areas of each country. $X_{i,t}$ represents control variables including *Size*, *ROE*, *Leverage*, *Investment_Opportunity*, *Capital_Expenditure*, *Research & Development*, *Environmental Stringency*, *GDP_Capita* and *CO2* while Φ_i and θ_t represent firm and year fixed-effects. Finally, $\varepsilon_{i,t}$ represents firm time specific error term and is clustered at industry-level.

I report the regression results in Model (1) of Table 2, which shows that the coefficient of *Air_Pollution* is negative and statistically significant at the 1% level with *Emission_Score*. This finding suggests that firms from countries with severe air pollution care less about emission for their operation. Furthermore, stricter government policy does not improve emission strategy of firms based on coefficient of *Environmental Stringency* variable. In contrast, the firms from high CO2 level countries have high emission scores. This indicates that so far, greenhouse gases are more seriously considered than air pollution.

Then in Model (2) of Table 2, I examine whether *Environmental Stringency* mitigates such negative impact. The interaction term of *Environmental Stringency* and *Air_Pollution* is negative, indicating that governments' strict policy on emission does not encourage firms to reduce their emissions of pollutants but instead discourages even further to improve their emission strategy. This further suggests that the general perception on improving air quality in society is the driving factor for firms to reduce their emissions.

One significant change from Model (1) and Model (2) of Table 2 is that *Environmental Stringency* becomes statistically significant with the interaction term and the coefficient is positive. Also, the coefficient of *Environmental Stringency* is much bigger than that of negative coefficient of interaction term. This proposes that strict regulations at institutional level do encourage firms to reduce emission while the effectiveness is weaker for countries with poor air quality.

<Insert Table 2 here>

3.2. Instrumental approach

Air pollution can be lessened on the day if it rains. 'As a raindrop falls through the atmosphere, it can attract tens to hundreds of tiny aerosol particles to its surface before hitting the ground.'[2]

[2] https://news.mit.edu/2015/rain-drops-attract-aerosols-clean-air-0828

Following such scientific effectiveness of rain in the air pollution, I use countries' precipitation during the year as an instrument variable to carry out 2SLS analysis. In Model (1) of Table 3, high precipitation is negatively associated with air pollution which is consistent with scientific finding. Then, using the predicted values of *Air_Pollution*, Model (2) shows the consistent result with my main finding that poor air quality is negatively correlated with *Emission_Score*. This re-affirms my main finding that air pollution has negative impact on firms' emission strategies.

<Insert Table 3 here>

3.3. Firm Performance

The aim of this section is to explicitly show that the damage on firm performance is the driving factor for why firms do not improve their emission strategy when the air pollution is severe. First, firm performance measure (*Tobin's Q*) is regressed with *Emission_Score*. Model (1) shows that firms with higher *Emission_Score* have poorer firm performance. This can be explained by inefficiency of operation if strategy is too environmentally focused (Hillman and Keim, 2001; Brown, Helland, and Smith, 2006; Di Giuli and Kostovetsky, 2014; Masulis and Reza, 2015). Can the government intervene and encourage firms to take stronger action on emission for better air quality?

Model (2) examines if the government policy can motivate firms to improve emission scores. Interaction terms of *Emission_Score* and *Environmental Stringency* has a positive and statistically significant coefficient with *Tobin's Q*, suggesting that strict environmental policy encourage firms to follow government's action by aiding them to improve their firm performance. Government intervention is a critical factor to encourage firms to improve their emission strategies so that they can achieve better firm performance.

<Insert Table 4 here>

4. Additional analysis

4.1. Industries

This section tries to find which industries drive the main finding of the paper as some industries perform better in terms of environmental scores (Borghesi et al., 2014). The first industry I examine is transportation industry (SIC Code 4000 – 4800) which uses large amount of petrol and fuels that contribute significantly to poor air quality. Model (1) of Table 5 shows that the interaction term of *Air_Pollution* and transportation industry dummy (*Transportation*) is statistically insignificant, suggesting that regardless of the air quality, transportation industry keeps consistent strategy on emissions.

Next industry examined is similar to the first industry I examine but it is energy transportation industry (SIC Code 1000 – 1400). Oil, gas and metals are heavily shipped globally, which are also main contributors to the poor air quality. Model (2) examines if the transporter who handle them are more environmentally aware and try to reduce emission during transportation. The coefficient of interaction term *Air_Pollution* and energy transportation industry dummy (*Energy Transportation*) is positive and statistically significant, showing that energy transporters try to reduce emission when the air pollution is severe.

Next industry I look at is energy production industry (SIC Code 3510 – 3590). This is to check if high technology industry (involving machineries), which are expected to be innovative and energy efficient, tries to improve emission strategy when the air pollution is poor. Model (3) shows that the interaction term of *Air_Pollution* and high technology industry dummy (*High_Tech*) has a negative and statistically significant coefficient. This indicates that the ones who can significantly improve our environment actually put less effort than other industries to reduce emission.

Industries with high market competition tend to incentivize firms to be more engaged in environmentally responsible practices (Campbell, 2007; Flammer, 2015). Model (4) tries to show if industries with high market competition more react to air pollution and change their emission strategy. Based on the insignificant coefficient of *Herfindahl_Index* and interaction term of *Herfindahl_Index* and *Air_Pollution*, market competition is not an important factor that influences emission strategies of firms when air pollution is poor.

Overall results show that it is not the pressure within the industry but how the industry self-regulate firms is a more important and effective factor that can reduce emission coming from specific industries.

<Insert Table 5 here>

4.2. Innovative firms

According to Fu et al. (2020), firms with high research and development have better expertise in environmental and social performance through synergies. However, the interaction term of *Research & Development* and *Air_Pollution* in Model (1) of Table 6 has a statistically insignificant coefficient, suggesting that firms with high research and development expenditure do not put in efforts to improve emissions. Instead of measuring innovation based on research and development expenditure, Model (2) uses *Innovation_Score* from *Refinitiv* which measures ‘a company's management commitment and effectiveness towards supporting the research and development of eco-efficient products or services’. Model (2) shows that the interaction term of *Innovation_Score* and *Air_Pollution* is positive and statistically significant, indicating that firms who are serious on innovation are also environmentally aware.

<Insert Table 6 here>

4.3. Public image

Firms who have more eyes watching them are likely to behave environmentally friendly when the air pollution is severe. This is because a great public image is important for their performance when they have more exposure to the public. Servaes and Tamayo (2013) show that socially responsible firms can perform better only when they advertise more. To test my accusation, I use the media coverage to test if firms with high exposure in the media are more likely to improve their emission strategy for a good public image. Model (1) of Table 7 shows that the interaction terms of *Media_Coverage* and *Air_Pollution* has a positive and statistically significant coefficient. The provides empirical evidence that firms who are more often covered in the media react to air pollution and put in effort to reduce emission.

Another variable to check if firms react more to the air pollution for a good public image is based on the Corporate Social Responsibility (CSR) strategy score from *Refinitive*. The CSR strategy score ‘reflects a company’s practices to communicate that it integrates economic (financial), social and environmental dimensions into its day-to-day decision-making processes.’ Firms with high CSR strategy score (*CSR*) is likely to have a good public image and act in a way that is consistent with the public sentiment. If the air pollution is severe the overall public will want to reduce it because it is directly related to their health. Model (2) of Table 7 shows that the interaction term of *CSR* and *Air_Pollution* has a positive and statistically significant coefficient, suggesting that firms with high *CSR* react more to the air pollution and improve their emission strategy for even greater public image.

<Insert Table 7 here>

4.4. Institutional Ownership

Institutional ownership is another factor that can influence emission strategies of firms (e.g. Borghesi et al., 2014; Gillan et al., 2010; Nofsinger tet al., 2019; Chava, 2014; Fernando et al., 2017). While the empirical findings on the impact of institutional ownership on firms’ environmental strategies are mixed, I try to examine if they influence firms when the air pollution is severe. I test five different types of institutional ownership: total institutional ownership (*IO*), foreign institutional ownership (*IO_For*), domestic institutional ownership (*IO_Dom*), civil institutional ownership (*IO_Civil*) and top 5 institutional ownership (*IO_Top 5*). Table 8 shows that the interaction terms of *Air_Pollution* and ownership variables are all statistically insignificant. The results empirically propose that institutional investors do not pressure firms to be more socially responsible when the air pollution is severe.

<Insert Table 8 here>

5. Conclusion

In this paper, I investigate the impact of air pollutions on firms' emission strategy. Using a sample of 9,684 firms from 65 countries, I find that firms' effort to reduce emission are lower for countries with severe air pollution. Such behaviour of firms cannot be stopped even with strong regulations on environmental protection. To alleviate endogeneity, I adopt 2SLS analysis with the annual precipitation as an instrument variable and find consistent results as my main findings.

I also examine the one economic mechanism that government's action can encourage firms to reduce emissions: being supportive toward socially responsible firms for better firm performance. I empirically show that socially responsible firms from countries with high environmental stringency and severe air pollution perform well. This finding suggests that government's role in reducing emission in the industry is crucial. Furthermore, I also show that innovative firms try to reduce emission more when air pollution is severe while firms which have large exposure to the public try to reduce emission as well.

My study contributes to the literature on the air pollution and firm performance by showing that air pollution can be reduced from government's action by it supporting the firms' socially responsible strategy. This is one possible direction that both government and firm take to reduce emission across the world while not hurting the economy and firm performance.

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Table 1: Summary Statistics

	Observations	Mean	Std	P1	P25	Median	P75	P99
Emission_Score	27,496	0.379	0.333	0.000	0.000	0.339	0.675	0.987
Air_Pollution	27,496	2.432	0.513	1.911	2.091	2.240	2.567	4.119
Size	27,496	21.718	1.668	17.325	20.720	21.793	22.789	25.544
ROE	27,496	0.010	4.927	-1.811	0.022	0.100	0.181	1.083
Leverage	27,496	0.246	0.186	0.000	0.097	0.237	0.364	0.716
Investment_Opportunity	27,496	1.144	83.186	-0.516	-0.005	0.056	0.147	2.467
Capital_Expenditure	27,496	0.051	0.067	0.000	0.017	0.035	0.065	0.283
Research & Development	27,496	0.001	0.007	0.000	0.000	0.000	0.000	0.014
Environmental Stringency	27,496	1.040	0.335	-0.186	0.990	1.072	1.235	1.486
GDP_Capita	27,496	10.563	0.767	7.457	10.590	10.855	11.001	11.348
CO2	27,496	2.319	0.542	0.505	2.016	2.686	2.736	2.800

Table 2: Baseline Findings

In this table, I present the regressions of *Air_Pollution* variable on the *Emission_Scores*. Firm level controls *Size, ROE, Leverage, Investment_Opportunity, Capital Expenditure* and *Research & Development* while country-level controls include *Environmental Stringency, GDP_Capita* and *CO2*. Results are obtained from regressions with firm and year fixed effects. The values of the t-statistics in parentheses are based on robust standard errors clustered at the industry level.

	(1)	(2)
	Emission_Score	*Emission_Score*
*Air_Pollution * Environmental Stringency*		**-0.061****
		(-2.62)
Air_Pollution	**-0.137*****	**-0.082****
	(-5.16)	**(-2.40)**
Size	0.020***	0.020***
	(7.93)	(7.87)
ROE	0.000	0.000
	(0.81)	(0.80)
Leverage	0.046***	0.045***
	(2.86)	(2.81)
Investment_Opportunity	-0.000	-0.000
	(-0.74)	(-0.75)
Capital_Expenditure	-0.056***	-0.058***
	(-4.31)	(-4.65)
Research & Development	-0.156	-0.158
	(-0.95)	(-0.97)
Environmental Stringency	-0.004	0.157**
	(-0.27)	(2.50)
GDP_Capita	0.074***	0.064***
	(3.24)	(2.70)
CO2	0.183***	0.234***
	(3.81)	(4.91)
Firm-Fixed Effect	Yes	Yes
Year-Fixed Effect	Yes	Yes
Observations	27,496	27,496
R-squared	0.902	0.902

Table 3: Endogeneity Test

In this table, I present the 2SLS regressions of *Air_Pollution* variable on the *Emission_Scores* with *Precipitation* as an instrumental variable. Firm level controls *Size*, *ROE*, *Leverage*, *Investment_Opportunity*, *Capital Expenditure* and *Research & Development* while country-level controls include *Environmental Stringency*, *GDP_Capita* and *CO2*. Model (1) shows the first-stage regression of 2SLS analysis while model (2) shows regression with predicted value of *Air_Pollution*. Results are obtained from regressions with firm and year fixed effects. The values of the t-statistics in parentheses are based on robust standard errors clustered at the industry level.

	(1) *Air_Pollution*	(2) *Emission_Score*
Precipitation	**-0.133*** **	
	(-6.09)	
Air_Pollution_hat		**-0.190*** **
		(-3.26)
Size	-0.004**	0.019***
	(-2.19)	(6.93)
ROE	-0.000	0.000
	(-0.29)	(0.78)
Leverage	0.017**	0.040***
	(2.09)	(2.71)
Investment_Opportunity	0.000	-0.000
	(1.21)	(-0.69)
Capital_Expenditure	0.018	-0.050***
	(1.41)	(-4.28)
Research & Development	0.155	-0.092
	(0.93)	(-0.55)
Environmental Stringency	0.048***	0.014
	(3.50)	(0.88)
GDP_Capita	-0.260***	0.049*
	(-12.09)	(1.95)
CO2	0.322***	0.206***
	(15.44)	(4.47)
Firm-Fixed Effect	Yes	Yes
Year-Fixed Effect	Yes	Yes
Observations	27,496	27,496
R-squared	0.992	0.019

Table 4: Firm Performance

In this table, I present the regressions of *Emission_Score* variable on the Firm Performance *(Tobin's Q)*. Firm level controls *Size, ROE, Leverage, Investment_Opportunity, Capital Expenditure* and *Research & Development* while country-level controls include *Environmental Stringency, GDP_Capita* and *CO2.* Results are obtained from regressions with firm and year fixed effects. The values of the t-statistics in parentheses are based on robust standard errors clustered at the industry level.

	(1) *Tobin's Q*	(2) *Tobin's Q*
*Emission_Score * Environmental_Stringency*		**0.134***** **(2.99)**
Emission_Score	**-0.127***** **(-5.77)**	**-0.265***** **(-6.00)**
Air_Pollution	-0.014 (-0.23)	-0.010 (-0.16)
Size	0.337*** (22.28)	0.336*** (22.25)
ROE	-0.002*** (-4.85)	-0.002*** (-4.89)
Leverage	0.140 (1.50)	0.140 (1.49)
Investment_Opportunity	-0.000* (-1.77)	-0.000* (-1.79)
Capital_Expenditure	0.359*** (3.85)	0.358*** (3.87)
Research & Development	-0.336 (-0.86)	-0.321 (-0.83)
Environmental_Stringency	0.001 (0.03)	-0.046 (-1.30)
GDP_Capita	-0.246*** (-4.85)	-0.247*** (-4.83)
CO2	0.015 (0.26)	0.031 (0.52)
Firm-Fixed Effect	Yes	Yes
Year-Fixed Effect	Yes	Yes
Observations	27,496	27,496
R-squared	0.909	0.909

Table 5: Industries

In this table, I present the regressions of *Air_Pollution* variable on the *Emission_Scores* for different industries; transportation industry in Model (1), energy transportation industry in Model (2), high technology industry in Model (3) and highly competitive industry measured by Herfindahl index in Model (4). Firm level controls *Size, ROE, Leverage, Investment_Opportunity, Capital Expenditure* and *Research & Development* while country-level controls include *Environmental Stringency, GDP_Capita* and *CO2*. Results are obtained from regressions with firm and year fixed effects. The values of the t-statistics in parentheses are based on robust standard errors clustered at the industry level.

	(1) *Emission_Score*	(2) *Emission_Score*	(3) *Emission_Score*	(4) *Emission_Score*
*Transportation * Air_Pollution*	**-0.005**			
	(-0.07)			
*Energy_Transportation * Air_Pollution*		**0.131*** **		
		(5.38)		
*High_Tech * Air_Pollution*			**-0.226*** **	
			(-8.79)	
*Herfindahl_Index * Air_Pollution*				**-0.005**
				(-0.14)
Herfindahl_Index				**-0.042**
				(-0.52)
Air_Pollution	-0.140***	-0.147***	-0.131***	-0.121***
	(-5.27)	(-5.54)	(-5.08)	(-4.33)
Control Variables	Yes	Yes	Yes	Yes
Firm-Fixed Effect	Yes	Yes	Yes	Yes
Year-Fixed Effect	Yes	Yes	Yes	Yes
Observations	27,496	27,496	27,496	25,706
R-squared	0.902	0.902	0.902	0.903

Table 6: Innovative Firms

In this table, I present the regressions of *Air_Pollution* variable on the *Emission_Scores* with interactions terms of *Air_Pollution and* innovation variables. *Firm* level controls *Size, ROE, Leverage, Investment_Opportunity*, *Capital Expenditure* and *Research & Development* while country-level controls include *Environmental Stringency, GDP_Capita* and *CO2*. Results are obtained from regressions with firm and year fixed effects. The values of the t-statistics in parentheses are based on robust standard errors clustered at the industry level.

	(1) *Emission_Score*	(2) *Emission_Score*
*Research & Development * Air_Pollution*	**-0.558**	
	(-0.72)	
*Innovation_Score * Air_Pollution*		**0.048****
		(2.22)
Innovation_Score		**0.020**
		(0.33)
Air_Pollution	-0.140***	-0.138***
	(-5.35)	(-5.71)
Size	0.020***	0.019***
	(7.26)	(6.88)
ROE	0.000	0.000
	(0.81)	(0.50)
Leverage	0.040***	0.039***
	(2.70)	(2.81)
Investment_Opportunity	-0.000	-0.000
	(-0.74)	(-0.72)
Capital_Expenditure	-0.052***	-0.054***
	(-4.37)	(-4.69)
Research & Development	1.133	-0.073
	(0.70)	(-0.44)
Environmental Stringency	0.011	0.012
	(0.73)	(0.79)
GDP_Capita	0.064***	0.056**
	(2.77)	(2.56)
CO2	0.191***	0.158***
	(4.21)	(3.64)
Firm-Fixed Effect	Yes	Yes
Year-Fixed Effect	Yes	Yes
Observations	27,496	27,496
R-squared	0.902	0.904

Table 7: Public Exposure

In this table, I present the regressions of *Air_Pollution* variable on the *Emission_Scores* with interaction terms of *Air_Pollution* and public exposure variables. Firm level controls *Size, ROE, Leverage, Investment_Opportunity, Capital Expenditure* and *Research & Development* while country-level controls include *Environmental Stringency, GDP_Capita* and *CO2.* Results are obtained from regressions with firm and year fixed effects. The values of the t-statistics in parentheses are based on robust standard errors clustered at the industry level.

	(1) *Emission_Score*	(2) *Emission_Score*
*Media_Coverage * Air_Pollution*	**0.008***** **(3.63)**	
Media_Coverage	**-0.015***** **(-2.70)**	
*CSR_Score * Air_Pollution*		**0.034**** **(2.48)**
CSR_Score		**0.255***** **(6.85)**
Air_Pollution	-0.158*** (-5.95)	-0.122*** (-5.55)
Size	0.020*** (7.46)	0.015*** (7.89)
ROE	0.000 (0.83)	-0.000 (-0.37)
Leverage	0.039*** (2.70)	0.031** (2.60)
Investment_Opportunity	-0.000 (-0.76)	-0.000 (-0.75)
Capital_Expenditure	-0.051*** (-4.41)	-0.036*** (-3.38)
Research & Development	-0.110 (-0.64)	-0.152 (-0.86)
Environmental Stringency	0.013 (0.86)	0.010 (0.62)
GDP_Capita	0.063*** (2.71)	0.036 (1.59)
CO2	0.186*** (4.17)	0.178*** (4.83)
Firm-Fixed Effect	Yes	Yes
Year-Fixed Effect	Yes	Yes
Observations	27,496	27,496
R-squared	0.902	0.916

Table 8: Institutional Ownership

In this table, I present the regressions of *Air_Pollution* variable on the *Emission_Scores* with interaction terms of *Air_Pollution* and institutional ownership variables. Firm level controls *Size, ROE, Leverage, Investment_Opportunity, Capital Expenditure* and *Research & Development* while country-level controls include *Environmental Stringency, GDP_Capita* and *CO2*. Results are obtained from regressions with firm and year fixed effects. The values of the t-statistics in parentheses are based on robust standard errors clustered at the industry level.

	(1) *Emission_Score*	(2) *Emission_Score*	(3) *Emission_Score*	(4) *Emission_Score*	(5) *Emission_Score*
*Air_Pollution * IO*	**-0.038**				
	(-0.71)				
IO	**0.077**				
	(0.61)				
*Air_Pollution * IO_For*		**-0.086**			
		(-1.53)			
IO_For		**0.290****			
		(2.06)			
*Air_Pollution * IO_Dom*			**-0.034**		
			(-0.56)		
IO_Dom			**0.011**		
			(0.08)		
*Air_Pollution * IO_Civil*				**0.024**	
				(0.21)	
IO_Civil				**0.192**	
				(0.67)	
*Air_Pollution * IO_Top 5*					**-0.061**
					(-0.86)
IO_Top 5					**0.150**
					(0.91)
Control Variables	Yes	Yes	Yes	Yes	Yes
Firm-Fixed Effect	Yes	Yes	Yes	Yes	Yes
Year-Fixed Effect	Yes	Yes	Yes	Yes	Yes
Observations	25,504	25,504	25,504	25,504	25,504

R-squared	0.903	0.903	0.903	0.903	0.903