Environmental Ethics, Financial Productivity and Carbon Pricing *

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Abstract

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Abstract

We model the firm's objective as a function of financial output and environmental ethics. The cost of emission increases with production and is weighted by firms' environmental ethics, leading firms to endogenize the optimal emission-output level. Firms with higher environmental ethics have higher marginal financial output and emit less because of the higher emission cost. More importantly, we argue that the one-size-fits-all carbon pricing is not optimal. Instead, carbon emissions should be priced based on the efficiency of the emission. Given a fixed carbon cap, switching to efficiency-based carbon pricing increases social welfare. Using emission data from 1995 to 2020, we provide empirical evidence to support the theory.

Keywords: Carbon pricing; Financial performance; Environmental ethics; Social welfare.
JEL Codes: G32; Q52; M14

1 Introduction

Climate change is the most pressing socioeconomic emergency of the century (Stern (2006); Akey and Appel (2021); Bartram et al. (2021)). The US Environmental Protection Agency (EPA) reported a global increase of 47% in greenhouse gases between 1990 and 2015[1]. Greenhouse effect, a phenomenon detected in 1800s,[2] has recently started drawing attention from governments and organizations around the globe with IPCC[3] suggesting a 50% global reduction in emissions to limit the global warming at 1.5°C above pre-industrial levels. However, we still lack a viable solution to strategically and steadily decrease carbon emissions without squeezing economic activity.

Any response to this global issue faces the constraint of not hampering economic activity. A viable approach to this apparent conundrum can be devised by understanding two components: the incentives of firms to be environmentally responsible (ethics) and the elasticity of firms' financial performance to the commitment. These two components are difficult to disentangle as adopting pro-environment practices is endogenous to firms' objectives. Evidence shows that there is heterogeneity across firms in terms of their pollution levels.[4] Furthermore, there is no explicit relation between environmental ethics and profitability. These challenges make it difficult to uncover the role and the value of environmental conscience: is it an inner reward with little material returns, or is it a value-enhancing strategy of firms to respond to evolving customer preferences and behavior?

We attempt to theoretically and empirically investigate the role of environmental ethics in shaping firms' decisions on emission and output. Before touching on the theory, let us consider a simple example. There are two firms, firm A emitting 800 thousand short tons of CO_2 equivalent and firm B emitting 1 million short tons of CO_2 equivalent. These figures

[1] https://www.epa.gov/climate-indicators/climate-change-indicators-global-greenhouse-gas-emissions

[2] https://www.nationalgeographic.com/environment/article/greenhouse-gases

[3] Intergovernmental Panel on Climate Change

[4] McCormich is building a more sustainable brand, while Coca-Cola, Pepsi and Nestlé named top plastic polluters for third year in a row. https://www.forbes.com/sites/jefffromm/2021/09/07/mccormick-is-building-a-more-sustainable-brand/ and https://www.theguardian.com/environment/2020/dec/07/coca-cola-pepsi-and-nestle-named-top-plastic-polluters-for-third-year-in-a-row

would suggest that firm A is more environmentally cautious than firm B. Now, assume that firm A achieves a profit of 100 million USD, while firm B's profit is relatively 500 million USD. This implies that for the same level of emissions, firm B is more profitable ($500 per ton of CO_2 for firm B versus $125 per ton of CO_2 for firm A), or more *efficient*. The absolute value of emissions is therefore a one-sided measure of a firms' environmental ethics that may lead to socially suboptimal choices. The intuition is that looking at pollution as a production factor and given that production requires an unavoidable[5] amount of pollution, firms exhibit different level of efficiency in utilizing such production factor and the most efficient firms are the ones with the highest value of scaled profits. We thus construct a variable called *"scaled profit"* to measure the efficiency of pollution and define it as the ratio of firms' profit to total emission.

We develop a model where the firm's objective is the financial output net of environmental costs. We assume that carbon emissions are one of the inputs in firms' output function, positively impacting output. On the other hand, carbon emissions are associated with a cost. Firms endogenize the optimal output-emission level given heterogeneous environmental ethics. We show that the firm with higher environmental ethics ("green firm" thereafter) has higher efficiency of emission/output.

We extend the model to feature the prevalent cap-and-trade regime[6] and compare social welfare under the uniform carbon pricing and our proposed efficiency-based carbon pricing. For the same amount of reduction in emission, efficiency-based carbon pricing can help achieve the social optimum by adjusting firms' intrinsic costs of emission and nudging the green firm to consume more carbon credit to achieve higher output.

The intuition behind our model can be understood as follows: under the uniform carbon pricing regime, the green firm emits less and is likely to sell the extra carbon certificates to the brown firm. Switching to efficiency-based carbon pricing means efficient production is "rewarded" with a lower carbon price given the same carbon cap. Facing a lower emission

[5] The fixed amount of pollution varies over time but at any time t it is fixed for every firm i

[6] https://www.c2es.org/content/market-based-state-policy/

cost, the green firm's incentive to sell the carbon certificates decreases, shifting the optimal output to the right. The basic idea of differential carbon pricing is that it is more economically sound to induce the green firm to consume instead of selling the allocated carbon credit because it creates more value concerning a higher output than the brown firm.

The value of switching from uniform carbon pricing to differential carbon pricing depends on the production gain from the green firm's additional carbon credit consumption relative to the social loss from the brown firm's further reduction in emissions. We show that this value increases with the emission reduction goal set by the government. In other words, efficiency-based carbon pricing adds more value to a greater reduction in emission intensity.

The model hints at the government's role in allocating scarce carbon resources to firms with a carbon constraint. The model also offers an informative indicator of marginal output based on which policymakers can distinguish a green firm from a brown firm.

We corroborate our theoretical model through a set of empirical analyses. We start by constructing our primary variable, the *green index*, as a proxy for environmental ethics. We model environmental ethics as a time-invariant feature of corporate culture to mitigate the concerns about "greenwashing" and "window dressing." We build the index by compiling a 56-keywords dictionary and use a Python programming language text mining algorithm to scrape firms' 10-K files in the period 1995 and 2000. "Green index" for a firm is calculated as the proportion of the sentences where keywords appear to the total number of sentences in the 10-K. We then adopt the index as an explanatory variable of emissions in the subsequent 2001 to 2020 years. By estimating and applying the index in non-overlapping periods we avoid contemporaneity issues and ensure strict exogeneity. Looking at the impact of environmental ethics on the absolute carbon emission level by firms and we find no significant relationship between firms' environmental ethics and pollution levels. This surprising result does not align with the prevailing argument that firms sensitive to the environment emit less pollution but suggest that the standard approach to measuring this relation may be flawed.

Differently, we illustrate a positive relation between firms' environmental ethics and marginal output consistent with the predictions of our model. More in detail, we run a set of OLS regressions where the dependent variable is scaled profit, defined as a measure of profits divided by the absolute value of greenhouse gas emission measured in short tons of CO_2 equivalent, and environmental ethics measured through our synthetic index as the main explanatory variable. We use facility-level data on greenhouse gas emissions from the EPA's Clean Air Markets Division (CAMD) database for the period between 2001 and 2020. The results support our conjecture showing that an increase in the green index by 10% increases the expected mean scaled EBIT for parent firms by $39 per unit of emission, corresponding to a rise in about 590 million USD for the mean level of emission in our sample.

One of the concerns with our sample is that it mainly concentrates on firms with large electricity-generating plants that are required to report to EPA. Although we control for industry-fixed effects, some unobservable characteristics these firms share may drive our results. To mitigate this concern, we expand the sample to S&P 500 firms whose primary business relies on carbon emission, one of the critical assumptions in our model. The results support our hypothesis and show that the marginal effect of environmental ethics is positive and statistically significant for top polluting industries, which contribute more than 70% of emissions across S&P 500 companies, indicating that our model is more informative for carbon-intensive firms (SIC 29 and SIC 49).

The extant literature has produced a large number of comprehensive and extensive studies and meta-analyses (e.g. Galama and Scholtens (2021), Friede et al. (2015), Dixon-Fowler et al. (2013), Ambec and Lanoie (2008)) that try and understand the nexus and effects of sustainable investing on firm performance. However, results are still inconclusive. Some studies argue that firms' responsible behavior translates into rewards in the future. El Ghoul et al. (2011) show that firms with better CSR scores exhibit lower equity financing. Fatemi et al. (2018) find that increasing ESG strengths increases firm value. Other rewards can be interpreted as a lower cost of bank loans (Goss and Roberts (2011)) and human capital (Thakor and Bunderson (2021)), a lower tax rate (Huseynov and Klamm (2012)), and higher resilience during an unexpected shock (Lins et al. (2017)). Those works point out that responsible behavior serves as an evolved corporate strategy to exploit advantages from norm-constrained customers and eventually leads to "doing well by doing good." Researchers have also shown a positive association between firms' environmental performance and their financial performance (e.g. King and Lenox (2001), Wang et al. (2014), Makridou et al. (2019)). On the contrary, some papers take a philanthropic view which states that performing pro-social initiatives in the interest of society or managers forgoes profitable projects and results in over-investment. Barnea and Rubin (2010) show that instead of being a part of the value-enhancing plan, socially responsible behaviors induce agency costs that destroy shareholder value. Hassel et al. (2005) looking at Swedish companies, finds that environmental performance has a negative impact on firm value. Huang (2021) reviews meta-analytical studies to understand the motivation for a firm's ESG activities. The paper concludes that it is something other than corporate financial performance that drives the environmental and social behavior of the firm. Riedl and Smeets (2014) find that many investors are attracted to sustainable investing due to humanitarian motives.

This paper attempts at improving the understanding of firms' emissions and output patterns through the perspective of environmental ethics. Unlike previous literature[7] that only takes a binary look at the association of environmental ethics with firms' emission reduction and financial performance, our paper advances a two-sided version of both emission and output. The synthesis of the two provides a broader picture of the conflicts and the equilibrium of financial incentives and social norms. As a result of our approach, we are able to establish a plausible connection between environmental ethics and profitability. In particular, we add to the work in environment efficiency measurement literature[8] by introducing a variable, *scaled profit*, to measure the socially responsible behavior of a firm, that we both prove theoretically and empirically test. Our analysis provides strong supporting evidence to the prediction that firms with high environmental ethics, endogenously choose the production functions and generate higher profits per unit of emission.

Our paper also contributes to the debate on policy remedies to climate change and the

[7]see : Hart and Ahuja (1996); Ferrat (2021); Miah et al. (2021);Galama and Scholtens (2021)

[8]see : Trinks et al. (2020); Picazo-Tadeo and Deigo (2009)

effect they have on social welfare and economic activity. Natalia and Reguant (2014) find that cost of emission is almost fully passed on to consumer electricity prices. Recent literature finds environmental regulations to have a costly implication on employment, industrial economic activity, and workforce productivity[9]. A part of this literature focuses on these climate policies' coordination and implementation problems. Fowlie et al. (2016); Bushnell et al. (2017); Martin et al. (2014) study the impact of the externalities of the climate policies on welfare and global emission levels. Building on this literature, we propose a differential carbon pricing approach based on the firm's emission efficiency. This novel pricing structure may help governments to improve the allocation efficiency of carbon certificates shifting the attribution to more greener firms, thereby generating higher social welfare.

The remainder of the paper is structured as follows. Section 2 describes the theoretical model. Section 3 discusses our data and variable construction. Section 4 presents empirical analysis and results. Section 5 conducts robustness analysis. Section 6 concludes.

2 Theoretical Model

Based on the assumption that firms care about profit and the environment, we model firms' objectives as a function of emission and environmental ethics. Obtaining higher profit is at the cost of greater emission charges. Moreover, firms with high environmental ethics are more sensitive to emission costs than less environmentally ethical firms. Therefore, firms endogenize optimal emission levels according to their environmental ethics. We show that firms with high environmental ethics emit less and have high marginal output. We refer to firms with high marginal output as *efficient firms.*

We then explore the regulatory implications of heterogeneity in environmental ethics by incorporating firms' marginal output into pricing carbon credit. Under the uniform carbon pricing scheme, where all firms face the same charges on emissions, efficient firms underinvest in emissions. Switching from uniform pricing to efficiency-based pricing, where efficient firms

[9] For, e.g., see Ryan (2012);Walker (2011) Walker (2013)

will be charged less on emissions while less efficient firms will be charged more, efficient firms are subsidized by the government to produce until they reach the new optimal. Less efficient firms will emit the remaining carbon budget. The aggregate profit increases as the production shifts from less efficient to more efficient firms.

2.1 Scaled Profit and Environmental Ethics

Environmental resources, such as clean air, are limited and have a price. Although this price may or may not be an immediate expenditure shown up on firms' balance sheets, it affects firms' decision-making process if they are sensitive to the consequences after the emission. Therefore, firms' profitability hinges upon the trade-off between the reduction of output and environment cost ($C(e_i)$). Following this, we assume that the output is a function of emission, and the firms' objective is to maximize the output net of the cost of emission by choosing an emission level e.

$$\begin{aligned} \max_{e} \; Q_i^{free} &= \left\{ s_i f(e) - s_i C(e_i) \right\} \\ C(e_i) &= a_i g(e) \end{aligned} \tag{1}$$

The first component $s_i f(e)$ is the output of firm i with emission level e and asset size s_i (measured in dollars). The second component is the cost of emission $g(e)$ mediated by the firm's environmental ethic a_i. The multiplicative term indicates that the two types of cost, $g(e)$ and a_i, are complementary. We relax the connection between a_i and $g(e)$ to ensure that firms' environmental ethics are exogenous.

We make Assumption 1 to ensure the concavity of the net output.

Assumption 1. *The output $f(e)$ is concave in emission and $f(0) = 0$. The cost of emission $g(e)$ is convex in emission and $g(0) = 0$.*

The maximization leads to the first-order condition (primes denote first derivatives),

$$f^{'}(e) = a_i g^{'}(e) \tag{2}$$

To simplify the model, we abstract from the possible nonlinear nature of the cost of emission and assume that $g(e) = e$, which means the emission cost linearly increases in the emission. Suppose e_b^* and e_b^* are the optimal emission levels for the green and brown firms. Then the relationship in Equation (2) becomes,

$$f^{'}(e_i^*) = a_i \tag{3}$$

A firm's marginal output should equal environmental awareness to achieve optimal emission. Together with Assumption 1, Equation (3) shows that the optimal emission level of firms with high environmental ethics is lower than firms with low environmental ethics. Figure 2 shows these results. In Figure 2, the black curve is the output function $f(e)$ and the slope of dashed line represents the marginal output $\frac{f(e)}{e}$. The slope of tangent lines passing through points on $f(e)$ is the environmental awareness. We can find that the slopes of the tangent line and the line connecting the origin and points on $f(e)$ both decrease with e. A high environmental ethic leads to fewer emissions and high marginal output.

INSERT FIGURE 2 HERE

An environmentally-conscious firm (green firm) emits less because the same amount of emission costs it more than a less-conscious firm (brown firm). Furthermore, the marginal output, which is the output per unit of emission, is higher for the green firm and lower for the brown firm. Those arguments lead to our first hypothesis:

Hypothesis 1. *Firms with high environmental ethics have higher marginal output than firms with low environmental ethics.*

2.2 Carbon Pricing

There are a variety of market-based approaches to pricing carbon. Cap-and-trade is one of the most prevalent carbon pricing strategies being used in the U.S. and worldwide. In cap-and-trade schemes the government sets an upper limit on emissions and distributes carbon allowances to firms either free or in the auction. Firms trade allowances with each other with a price determined by the market supply and demand of allowances. First introduced in the European Union in 2005, cap-and-trade is adopted by Australia, New Zealand, South Korea, Canada (Quebec and Ontario), Mexico (pilot program in 2020), and China (regional program). In the U.S., 11 eastern states known as Regional Greenhouse Gas Initiative (RGGI)[10] and California[11] implement the cap and trade carbon pricing mechanism.

We frame our model in the existing cap and trade scheme[12] and discuss the social welfare in two types of carbon pricing framework: (1) the existing uniform carbon pricing and (2) a proposed productivity-based carbon pricing.

2.2.1 Government's Objective

We consider an economy with two firms, one green firm, and one brown firm. We assume the government's objective is to maximize the overall output net of the environmental cost faced by the two firms and the emission-related disutility faced by the public, given a carbon cap ($\overline{E}$).

$$\begin{gathered} V(\overline{E}) = \sum_{i\in\{g,b\}} \left\{ s_i[f(e_i) - C(e_i)] - D(e_i) \right\} \\ s.t. \sum_{i\in\{g,b\}} e_i = \overline{E} \end{gathered} \tag{4}$$

We introduce the following assumption 2 that incorporates the notion that balanced

[10]https://www.rggi.org/program-overview-and-design/elements

[11]https://www.c2es.org/content/california-cap-and-trade/

[12]We note two points about our simplified cap-and-trade framework. First, we assume firms receive equal free carbon allowances. We show in Equation (8) that the results do not depend on the initial allocation allowance. Second, we assume firms face the same carbon price in the market. It fits our setting of a two-firm economy, which means only one unique market price in the equilibrium.

emission combinations are less toxic than unbalanced emission combinations.

Assumption 2. *The disutility $D(e_i)$ is convex in the emission e_i and $D(e_i)$ is non-negative.*

A simple way to interpret it is that the public experiences less disutility from the average of two emission levels than from their respective absolute values.

The first-order condition for the social optimum is given by

$$f_i' = a_i + \frac{D_i' + \lambda}{s_i} \tag{5}$$

where λ is the Lagrange multiplier on the emission constraint. It indicates that for each firm, the marginal output should be equivalent to the sum of environmental ethics and the proportion of the marginal damage resulting from emission and the shadow value of the emission constraint in asset size. Any regulations that can help achieve this allocation as shown in Equation (5) are economically efficient.

2.2.2 Uniform Carbon Pricing

Assumption 3. *The government sets the carbon cap $2\overline{e}$ (equals $\overline{E}$), which is lower than the aggregate emission of firms without being charged on emissions ($2\overline{e} < e_g^* + e_b^*$, where e_g^* and e_b^* are the optimal emission levels for the green and brown firms without facing any emission charges). Firms face the same carbon price δ. The green and the brown firms' optimal emission levels and corresponding marginal outputs are e_g', e_b', $f'(e_g')$, and $f'(e_b')$, respectively.*

If we integrate the cap-and-trade scheme into the model, then the firms' cost function becomes,

$$s_i a_i g(e_i) + \delta(e_i - \overline{e}) \tag{6}$$

the objective of firms is to choose an emission level to maximize the net output,

$$Q_i^{uni} = \left\{ s_i f(e_i) - s_i a_i g(e_i) - \delta(e_i - \overline{e}) \right\} \tag{7}$$

the first order condition is,

$$s_i[f'(e_i) - a_i g'(e_i)] = \delta \tag{8}$$

It indicates that the marginal profit, which is the difference between the marginal output and the internal marginal cost of emission, equals the price of a carbon certificate. In our simplified model, Equation 8 is $s_i[f'(e_i) - a_i] = \delta$. This condition states that firms with a certain level of environmental consciousness reduce emissions to the point where the marginal profit equals the market value of the emission, δ. When the marginal profit exceeds the marginal cost of additional emissions, firms will emit more than they are allowed to and fund the additional emissions through purchasing.

Moreover, Equation (8), together with Assumption 1, illustrates that the government can reduce any amount of emissions by adjusting the market price of allowance δ. If the optimal emission levels for the green and brown firms without charge on emissions are e_g^* and e_b^*, respectively. Given the carbon cap is $2\overline{e}$, a reduction in carbon emissions by ΔE ($\Delta E = e_g^* + e_b^* - 2\overline{e}$) is concave in the uniform carbon price δ.

Panel A of Figure 1 plots the optimal emission of each firm and the allowance trade mechanism. By decreasing emissions from e_g^* and e_b^* to respective e_g' and e_b', the green and brown firms achieve a higher marginal output by $\frac{\delta}{s_i}$ to meet the optimal condition. The emission reduction would be less for the green firm than for the brown firm because the green firm has higher marginal output to absorb the increasing cost of emission.

INSERT FIGURE 1 HERE

We make Assumption 4 to satisfy the demand-supply condition.

Assumption 4. *The market is cleared of all allowances.*

To reach the social optimum in Equation (5), firms need to choose emission levels that satisfy the following condition.

$$a_i + \frac{\delta}{s_i} = a_i + \frac{D_i' + \lambda}{s_i} \tag{9}$$

That is, δ needs to equal $D_i' + \lambda$ for each firm. It means that the cost of emission has to be proportional to the firms' marginal environmental impact. The condition indicates that the carbon price should reflect the output efficiency and be lower for productive firms. (Assumption 2)

Equation 8 suggests that the initial allowance allocation has no impact on firm decisions. Differently, our model indicates the price channel, rather than the initial allowance allocation channel as the most effective way through which the government can improve social welfare. We consider this implication in the next section.

2.2.3 Marginal Output-Based Carbon Pricing

As mentioned in Section *2.2.2*, the carbon price should reveal firms' marginal output. (Assumption 5) We make an extreme case to help us understand the differential pricing mechanism. (Assumption 6)

Assumption 5. *Under the marginal output-based carbon pricing, the carbon price δ decreases in the marginal output $\frac{f(e)}{e}$. The green and brown firms' optimum emission levels and marginal outputs are e_g'', e_b'', $f'(e_g'')$, and $f'(e_b'')$ respectively. The difference in the optimal emission levels between the two pricing schemes is Δe ($\Delta e = e_g'' - e_g'$) for the green firm and $-\Delta e$ for the brown firm.*

Assumption 6. *The green firm's marginal output is so high that the carbon price for the green firm approximates to zero, $\delta_g \to 0$. The brown firm is charged a price, δ_b.*

Since it is costless for the green firm to emit, the optimal emission for the green firm is that in which the marginal output equals the environmental awareness, i.e. $e_g'' = e_g^*$ referring to Equation 3. The brown firm is disciplined to emit the remaining carbon budget $e_b'' = 2\overline{e} - e_g''$ by being charged at a higher price for buying allowances.

According to Equation 7, compared to being under the uniform carbon pricing, the changes in net outputs for the green and brown firms under the differential pricing,

$$\begin{aligned}
\Delta Q_g = Q(e''_g) - Q(e'_g) = \\
\{s_g f(e''_g) - s_g a_g g(e''_g)\} - \{s_g f(e'_g) - s_g a_g g(e'_g) - \delta(e'_g - \overline{e})\} \\
\Delta Q_b = Q(e''_b) - Q(e'_b) = \\
\{s_b f(e''_b) - s_b a_b g(e''_b) - \delta(e''_b - \overline{e})\} - \{s_b f(e'_b) - s_b a_b g(e'_b) - \delta(e'_b - \overline{e})\}
\end{aligned} \tag{10}$$

We rearrange Equation 10 and get the following results.

$$\begin{aligned}
\Delta Q_g = s_g[f(e''_g) - f(e'_g)] - s_g a_g[g(e''_g) - g(e'_g)] + \delta(e'_g - \overline{e}) \\
\Delta Q_b = s_b[f(e''_b) - f(e'_b)] - s_b a_b[g(e''_b) - g(e'_b)] + [\delta(e'_b - \overline{e}) - \delta_b(e''_b - \overline{e})]
\end{aligned} \tag{11}$$

Equation 11 suggests that the change in profits of the green (brown) firm comes from three parts: the increased (decreased) output, the decreased (increased) marginal output, and the loss of selling (buying) carbon allowances.

The third term, changes in returns of trading carbon allowances, is always negative for the green firm. Under a differential pricing scheme, the green firm is indifferent to buying extra allowances to emit more and selling more than needed allowances to earn credit. Unlike in the uniform carbon pricing scheme (Assumption 5), the green firm loses earning from selling additional allowances in the differential pricing framework. The new pricing scheme transfers part of the green firm's earnings from trading allowances to society.

Panel B of Figure 1 shows these results. The area enclosed in the blue frame represents the brown firm's reduced profit and is larger than the corresponding area in Panel A of Figure 1. The change in the total profit is the difference between the sum of areas enclosed in red and blue frames.

Now, let us consider the change in social welfare. We plug the optimal emissions for the green and brown firms under two carbon pricing schemes into Equation 4 and get the following equation (the subscript "eff" and "uni" denote efficiency-based and uniform carbon pricing schemes).

$$
\begin{aligned}
V_{eff} - V_{uni} = & \sum_{i\in\{g,b\}} \left\{ s_i[f(e_i'') - C(e_i'')] - D(e_i'') \right\} - \sum_{i\in\{g,b\}} \left\{ s_i[f(e_i') - C(e_i')] - D(e_i') \right\} \\
= & \underbrace{\left[s_g \int_{e_g'}^{e_g} f'(e)de - s_b \int_{e_b''}^{e_b'} f'(e)de \right]}_{\text{production gain}} \\
& - \underbrace{\left[s_g a_g (e_g - e_g') - s_b a_b (e_b' - e_b'') - \delta \Delta E + \delta_b (e_b'' - \overline{e}) \right]}_{\text{social cost from firms' environmental cost}} \\
& - \underbrace{\left[D(e_g) + D(e_b'') - D(e_g') - D(e_b') \right]}_{\text{disutility}}
\end{aligned}
\tag{12}
$$

Suppose the output function is $\theta log(e+1)$, where θ measures the business environment. We denote the increase (decrease) in carbon emission for the green (brown) firm compared to uniform carbon pricing as Δe. We replace the output in Equation 12 and rearrange it to get the Equation 13:

$$
\begin{aligned}
V_{eff} - V_{uni} = & \underbrace{\left[\theta log \left[1 + \frac{\Delta e}{e_g'}\right]^{s_g} \left[1 - \frac{\Delta e}{e_b'}\right]^{s_b} \right]}_{\text{output gain}} \\
& - \underbrace{\left[\Delta e (s_g a_g - s_b a_b) - \delta \Delta E + \delta_b (e_b' - \Delta e - \overline{e}) \right]}_{\text{social cost from firms' environmental cost}} \\
& - \underbrace{\Delta D(\overline{E})}_{disutility}
\end{aligned}
\tag{13}
$$

The first term is the"output gain": since the green firm can produce free of charge until reaching its optimal output level, its output is greater than the one under which it is charged for extra emission. The output gain is an increasing function of Δe. The intuition is that the benefit of free emission for the green firm is larger when the uniform carbon price is high.

The second term is the "social cost" from firms' environmental costs: the green firm has to bear greater emission costs when privileged to emit without charge. The social costs increase in Δe. A greater emission "recovery", the difference between the two optimal emission levels for the green firm under two pricing strategies, adds value to the efficiency-based pricing. The green firm passes intrinsically costly carbon emissions on to the brown firm that bears the less expensive marginal cost of emissions.

The third term is the "social cost" from the change in disutility. Given the same carbon cap $\overline{E}$ under two pricing schemes, the disutility decreases (Assumption 2).

Take the first derivative of Equation (13) with respect to Δe, we get

$$\frac{\partial[V_{eff} - V_{uni}]}{\partial \Delta e} = [\frac{s_g}{e_g^*} - \frac{s_b}{e_b''}] - (s_g a_g - s_b a_b - \delta_b) - D'(\overline{E}) \tag{14}$$

If two firms are of the same size (s) and the marginal disutility is negligible, Equation (14) can be written as

$$\frac{\partial[V_{eff} - V_{uni}]}{\partial \Delta e} = s(\frac{1}{e_g^*} - \frac{1}{e_b''}) - s[f'(e_g^*) - f'(e_b'')]$$

The equation above shows that the marginal value of switching to efficiency-based carbon pricing depends on how efficient the green firm is in emission and production compared to the brown firm. When the green firm has very high environmental ethics, which means the green firm emits and produces exceedingly efficiently, the gain in social value (Equation 13) of shifting to differential carbon pricing increases in the green firm's reduced emission, Δe. Since Δe is proportional to the total emission reduction, ΔE, we have our second hypothesis:

Hypothesis 2. *When firms are of similar size and when there are "super green" firms with high marginal output, switching from uniform carbon pricing to efficiency-based carbon pricing adds value. Moreover, the added value increases in the emission reduction target set by the government.*

We do not consider the proceeds from trading carbon allowances because the trading mechanism suggests that the government facilitates the transactions between firms. Thus, the government will invest the revenue from selling sustainable projects. Similar to the

California carbon auction scheme, the differential pricing setting shifts wealth from firms, especially the less efficient firms, or brown firms in our context, to the society given a particular carbon footprint.

3 Data and Variables

To examine the relationship between firms' environmental ethics and profits, we use data from multiple sources for the sample period between 2001-2020.[13] We deliberately choose the sample period starting from 2001 to remove the correlation with our main variable of interest, the green index, which is constructed using information from 1995 and 2000. We elaborate more on the green index in Section *3.1*. We extract yearly facility-level greenhouse gas emission data from the Clean Air Markets Division (CAMD) of the Environmental Protection Agency (EPA) to measure firms' pollution. The emission data covers electricity generating units with a capacity greater than 25 megawatts; therefore, the sample encompasses companies in industries such as utilities (NAICS 2211), mining (NAICS 2122), petroleum, and petroleum products merchant wholesalers (NAICS 4247), etc. The CAMD documents three air pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon dioxide (CO_2), in carbon dioxide equivalent short tons. We sum up three emissions to compute the facility-level emission.[14]

We supplement emission data with facilities' owner and operator information in a separate file from the CAMD and manually check the historical ownership (parent company) through 10-K filings and Google search. We eliminate observations that never appear in any searchable documents and merge the remaining data with financial statistics from Compustat.

Our final sample has 6,460 facility-year observations for 400 facilities and 793 company-

[13] The earliest Air Markets Program Data available on the EPA website is from 1995.

[14] According to the EPA data guide, CAMD's Power Sector Emission Data report approximately 96% of the fossil fuel generation in the U.S. in 2018. Apart from the three air pollutants mentioned above, electricity-generating units began reporting mercury emissions to EPA between 2015 and 2017. To consider consistency and comparability, we do not include mercury in the pollution calculation.

year observations for 53 firms from 2001-2020.

3.1 Measure of Firms' Environmental Ethics

We focus on the environmental dimension of a firm's sustainable behavior, which we refer to as "environmental ethics." Although a growing number of investors use SRI screening, no perfect standardized methodology is used to evaluate and screen corporations' sustainable behavior. The most commonly used measure of firms' environmental performance is the "E" pillar in ESG ratings from MSCI and Refinitiv, which utilize a wide array of criteria to evaluate a company's "strengths" and "weaknesses" in dealing with environmental issues.[15] However, these ratings suffer from the concern that the composition of the indicators changes over time; hence the aggregate score captures different perspectives of firms' environmental efforts and is not directly comparable in different periods.[16] Moreover, firms are incentivized to inflate ESG ratings to increase reputation, attract investors, and avoid regulatory scrutiny, leading to positive biases in the measure[17].

To mitigate these concerns, we construct a variable called *green index* as a proxy for firms' environmental ethics. Green Index is a time-invariant variable created in two steps. First, we establish a dictionary (provided in the Appendix A.1) including 56 environment-related keywords following the work of Henry et al. (2021)[18]. Then we scrape each firm's earliest 10-K filing in the period between 1995 and 2000 to compile our dictionary of environmental keywords and calculate the frequency as the ratio of the number of sentences that contain keywords to the total number of sentences. For example, if the first 10-K filing of company Z in the time window of 1995-2000 is in 1996, we use 10-K in 1996 to scrape words and calculate the frequency. We remove observations that do not have 10-K filings in this period because it is difficult to evaluate their environmental ethics and compute a com-

[15]see Liang and Renneboog (2017); Daugaard (2019).

[16]see Dorfleitner et al. (2015); Escrig-Olmedo et al. (2019)

[17]see Tang et al. (2021); https://www.marketwatch.com/story/this-is-what-youre-getting-wrong-about-esg-ratings-11644938978

[18]We read through some 10-Ks and drop keywords that are likely to appear in the irrelevant context.

parable value to the frequency-based green index. The green index is a continuous variable between 0 and 1, with a larger value indicating higher environmental ethics. As presented in Table 1, the green index value for our sample has a mean of about 0.028.

Similar to Eccles et al. (2012) strategy for identifying highly sustainable firms, when companies face relatively lax scrutiny, devoting resources to environmental issues is more like a voluntary choice that reflects corporate culture and belief rather than an opportunistic choice. Therefore, it is unlikely that the attitude toward environmental issues is correlated with profits or is determined by external pressure. We therefore compile our green index between 1995-2000, strictly before our sample period, in order to relieve endogeneity concerns.[19]

3.2 Dependent Variables

As our main dependent variable, we use "scaled profit", the ratio of gross profit to the total greenhouse gas emission in short tons. We take net income, EBIT, and EBITDA as alternative measures of profit for the robustness check. In the facility-level analysis, we equally divide the parent firm's profit among all facilities on a yearly basis following Shive and Forster (2020). To handle large outliers, we winsorize our dependent scaled_profit variable at 2.5% and 97.5% in all analyses.

3.3 Control Variables

Following prior literature, we control for a set of firm characteristics that are known to affect profit, emission, and scaled profit (Xu and Kim (2022); Bartram et al. (2021)). Specifically, we control for firm size using the natural logarithm of total assets, leverage, which is the ratio of total debt to total assets, and Tobin's Q, which is calculated as total assets less cash equivalent plus market equity divided by total assets to control for firms' growth and financial

[19]We conducted two robustness tests in Section *5.1* to validate that our measure adequately captures firms' awareness of environmental impacts.

position. We also include capital intensity, the ratio of property, plant, and equipment to total assets, to control the impact of total capital investment on our dependent variable.

Table 1 presents the summary statistics for parent firms in our sample. Firms in the sample have an average asset of about \$ 20 billion with a net income of \$ 480 million. We note that each parent firm on an average had close to 6 facilities that they were operating.

INSERT TABLE 1 HERE

4 Empirical Analyses and Results

4.1 Firms' Environmental Ethics and Emission

Higher environmental ethics calls for lower pollution emissions by firms. We test this conjecture by studying the impact of firms' environmental ethics on emission levels using a set of OLS regressions with the functional form outlined in Equation 15. The dependent variable is the absolute greenhouse gas emission in billions of short tons in year t, and the primary independent variable is the green index. For our sample, the green index variable is right-skewed. Thus, we log transform the green index to maintain the statistical validity of our regression results. We include year- and industry-fixed effects to condition out time-invariant factors across time and industry trends. We double-cluster our errors at the firm and year levels.

$$Emissions_{it} = \beta_0 + \beta_1 * ln(green\_index_i) + controls_{it} + \epsilon_{it} \tag{15}$$

Table 2 tabulates the results with facility-level results presented in Column 1. It shows that the coefficient on the green index is insignificant, suggesting that firms' environmental ethics cannot predict their emission levels. In Column 2 of Table 2, we aggregate the emission at the parent level and repeat the regressions. We find that the emission is positively related to the green index, and the coefficient is statistically significant at the 1% level. The positive coefficient on the green index indicates that higher environmental ethics is associated with more emissions.

INSERT TABLE 2 HERE

The interpretation of results is twofold. First, the inconsistency of the impact of environmental ethics on facility- and parent-level emissions indicates that environmentally conscious firms do not reduce emission uniformly across facilities. Second and similarly puzzling, by measuring the absolute emission, firms with high environmental ethics break the promise and emit more pollution. These counter intuitive results call for further investigation.

4.2 Firms' Environmental Ethics and Scaled Profit

An alternative explanation of the positive relationship between the green index and the emission level is that, though firms that care about the environment emit more, they produce more efficiently and generate a higher profit per unit of emission. From a social welfare perspective, sustainability and productivity both matter in the way that the total economic output needs to be maximized under a particular carbon emission constraint. As discussed in Section *2.1*, we test this relationship between firms' environmental ethics and emission by investigating the relationship between firms' environmental ethics and scaled profit. We replace the dependent variable with "scaled_profit" and repeat the regression in Equation (15) to test our first hypothesis.

Table 3 presents the result of facility-level regression for four measures of profit: net income, gross profit, EBIT, and EBITDA measured in thousands of US dollars. The facility-level emission scales all profit-related items. The coefficient on the green index is positive and statistically significant at the 1% level across four measures and is consistent with Hypothesis 1. The results show that firms with high environmental ethics are more likely to earn a greater profit per unit of emission. The magnitude of the coefficient on the log of the green index, which represents the incremental effect of environmental consciousness on profit per unit of emission, is 0.321-1.22. That is, an increase in environmental ethics by 10% is associated with an increase in profit per unit on an average of $84. This is equivalent to an increase of 1.27 billion US dollars for our sample's average emission of 15.14 million short tons.

INSERT TABLE 3 HERE

Table 4 shows the estimates of parent-level regression. The coefficient on the green index continues to be positive and statistically significant at the 1% level for scaled EBIT, indicating that highly conscious firms emit less for the same profitability level than firms with low environmental consciousness[20].

INSERT TABLE 4 HERE

These results, combined with the results from environmental ethics and emission analysis in *4.1*, indicate that solely focusing on the absolute emission cannot justify a firm's environmental impact because it requires less emission to keep the same profitability for firms with high environmental ethics than firms with low environmental ethics.

5 Robustness

5.1 Validating Green Index

An assumption underlying our construction of the green index is that firms that addressed environmental issues in their 10-Ks during the early years, when legislation and public awareness were limited, are more likely to behave ethically. However, two concerns arise: first, the use of pre-2000 years to construct the green index may seem arbitrary, and second, firms that mention environmental issues might not necessarily follow through on their commitments.

[20]We run the parent level regression trimming at the top 5% (excluding 3 parent firms) and find our results to be positive and have higher economic significance. The result is tabulated in Appendix A.2

To address these, we conduct two additional analyses to gauge whether the green index sufficiently captures firms' awareness of environmental impacts, and thus, their likelihood of behaving ethically

To show that there was no significant contemporaneous shock drawing attention to environmental issues before 2000, we use the Google Trend Index for environmentally related topics as a proxy for public awareness. The topics include "climate change," "what is carbon footprint," "what is carbon," "what are the greenhouse gases," and "how to reduce climate change." We also include three keywords from our dictionary, including "zero carbon," "climate action," and "circular economy." Although the earliest searchable year for Google Trend Index is 2004, we can infer trends from earlier periods. Figure 3 illustrates the monthly search index from January 2004 to August 2022, with 0 indicating minimal attention and 100 representing maximum attention. We observe a gradual increase in search interest for all topics after 2006, except for "what is a carbon footprint," which shows a relatively flat trend before 2006. This suggests that environmental issues were not prominently on the public's radar before 2006, and even less so before the year 2000, which is the time frame used to construct the green index.Therefore, firms that voluntarily disclosed environmental information during this period are more likely motivated by ethical considerations, rather than being influenced by broader macroeconomic factors.

INSERT FIGURE 3 HERE

Next, we examine the correlation between our green index and another major ESG rating, the Refinitiv rating. Specifically, we focus on two metrics, the Environmental Pillar Score and the ESG Emissions Score, as these align more closely with our context. Since the earliest available Refinitiv data begins in 2002, we calculate the correlation between the green index and these two metrics at both the start (2002) and the end (2020) of our sample period. Table 5 shows that, in 2002, the correlation between the ESG Emissions Score and the green index is 0.48, which is statistically significant at the 5% level, while the correlation between the Environmental Pillar Score and the green index is 0.3. Both correlations weaken by 2020.

INSERT TABLE 5 HERE

Furthermore, we categorize firms into "green" and "brown" groups based on whether their green index is above or below the median, and we track changes in ESG metrics over time for each group. Panel A and B of Figure 4 display the time series of the mean and median Environmental Pillar Score and ESG Emissions Score by group. Across both metrics, the Environmental Pillar Score consistently remains higher for green firms compared to brown firms, indicating that our green index is a reliable measure of environmental performance.

INSERT FIGURE 4 HERE

5.2 S&P 500 Companies

Since the emission data from CAMD focus primarily on industries that produce electricity (SIC two-digit Code 29 and 49), our results may be susceptible to unobserved characteristics shared by those industries. To prove that the results can shed light on other industries, we broaden the sample to S&P 500 companies that operate in SIC two-digit Codes 01-49. We exclude finance, insurance, real estate, services, retail trade, and wholesale trade. The rationale is that the business model of those firms is fundamentally different from that of firms in our sample, as their profit-making businesses do not require carbon intake (emission). Therefore, we should not expect a finance firm's output function to be the same as a utility firm's, which contradicts the critical Assumption in the model.

We extract the carbon emission of S&P 500 firms from the Thomson Reuters Eikon database. The Eikon database either collects or projects the CO_2 emissions depending on whether firms self-report the data.[21] Figure 5 depicts the industry share of carbon emission

[21] If a company has not reported its CO_2, a series of models will be triggered sequentially. Among 4,680

for industries whose carbon contribution is larger than 4% from 2002 and 2020.[22] These polluting industries account for more than 75% of the total emissions for S&P 500 firms. Moreover, two sectors, the electric, gas, and sanitary services and petroleum refining and related industries, generate the largest shares totaling 67.53%-88.46% of the total emission. Figure 6 shows the total emission trend and the top two polluting industries' emissions, represented by respective grey and brown lines. We can find that the changes in total emissions are almost fully driven by the changes in the top two industries' emissions. Taken together, these two plots indicate that even for firms that consider carbon as one of the inputs in their output function, their sensitivity of carbon intake to profit, or the cost of emission in our model, differs considerably from firms operated in electric, gas, and petroleum refining industries.

INSERT FIGURE 5 AND FIGURE 6 HERE

To spot the marginal effect of environmental awareness of top polluting industries (refer to electric, gas, and petroleum refining industries thereafter for brevity), we create a "polluter" dummy that takes value one if the firms' SIC is 29 or 49 and zero for others. We interact the dummy with the green index and report the result in Table 6. The coefficient on the green index is negative and statistically significant across four scaled profit measures, suggesting that higher environmental ethics relates to a lower scaled profit. However, the coefficient on the interaction term is positive and statistically significant. It means that compared to other firms, firms in polluting industries obtain a higher profit per unit of waste for an increase in environmental awareness.

INSERT TABLE 6 HERE

firm-year observations, 16.28% and 2.44% of them are estimated using the Median model ad Energy model, respectively. The methodology is described on the website `https://www.refinitiv.com/content/dam/marketing/en_us/documents/fact-sheets/esg-carbon-data-estimate-models-fact-sheet.pdf.`

[22] We eliminate the year 2001 because very few firms reported emissions. Additionally, the Eikon database cannot properly project emissions because 2001 is the earliest year in the database, and no preceding data are fed into projection models.

5.3 Enforcement Variable as a Proxy for Environmental Ethics

An environmentally-aware firm will work towards being environmentally compliant and should thus have fewer environment-related violations. U.S. EPA Enforcement and Compliance History Online(ECHO) website provides data on environmental enforcement actions. Specifically, we use Federal Enforcement and Compliance (FE&C) data from the Integrated Compliance Information System (ICS) database. A facility is issued enforcement for violating one of the eight environmental acts, including the Clean Water Act, the Clean Air Act, the Comprehensive Environmental Recovery and Liability Act, and the Resource Conservation and Recovery Act. We merge the data with our sample of facilities from the CAMD database.

We calculate the number of violations combined at the parent level per year from 2001-2020 to obtain the *cases per year* variable. We perform regression of Equation (15) with *cases per year* as the primary independent variable in place of the green index. The results are reported in Table 7. As conjectured, we see a negative relationship between enforcement cases and scaled profit. We do not find significance due to the small sample size and scanty matching between the two databases. Our results suggest that firms with more violations have reduced environmental efficiency of profit.[23]

INSERT TABLE 7 HERE

6 Conclusion

We develop a model of firms' optimal output-emission where firms make a trade-off between high output and high cost of emission. The heterogeneity of environmental ethics may act as a moderating device in internalizing the optimal output-emission level. We show that

[23] We also have regressed scaled profit with time-invariant enforcement variable equal to total cases for each firm up to the year 2000, and the results are consistent.

firms with high environmental ethics ("green firms") are susceptible to intrinsically higher costs of pollution, emit less, and generate higher marginal financial output, than firms with low environmental ethics ("brown firms"), both unconditionally and controlling for size. To support the theory, we provide empirical evidence in which we identify the positive relationship between firms' environmental ethics and their financial productivity measured by profits scaled by emissions.

These results provide policymakers and the public with a new theoretical and empirical baseline for understanding firms' emission behavior and its respective social welfare impact. In fact, we show that incorporating the concept of scaled profit into carbon pricing incentivizes green firms to consume rather than sell extra carbon certificates, creating more value in terms of higher output. Using efficiency-based carbon pricing as an instrument, the government serves as an intermediary to channel more carbon certificates toward the green firm. Simply put, firms compete for scarce carbon resources, and regulators distinguish the green firm from the brown firm according to their efficiency of emission and allocate carbon allowances across firms.

The implications are threefold. First, our model sheds light on firms' "doing well by doing good", showing that environmental ethics generate a trade-off and discipline firms' profit-oriented behavior. Second, the model suggests that scaled profits as a measure of the efficiency of emissions are a function of firms' environmental ethics that deserve attention in market regulation and policy design. Lastly, we suggest the possibility of welfare gains if policymakers could incorporate scaled profit into pricing schemes of carbon emissions.

Our model opens avenues for future research. For example, we focus on firms with the same sensitivity of output to carbon. However it would be interesting to expand our analysis to firms with endogenously determined response to environmental concerns. There is also an unexplored dynamic aspect of environmental ethics: environmental ethic evolves over time, and many factors, such as market competition, shareholder activism, management styles and objectives, and organizational structures do also change. How these joint changes play a role in determining the optimal output-emission level? How do these factors change the social optimum accordingly, and under what circumstances? We leave these questions for future research.

Tables

Table 1: Summary statistics

This table represents the summary statistics for parent firms in our sample. 'Leverage' is defined as ratio of the total debt to the total assets. 'Capital intensity' is defined as the ratio of plant, property and equipment to total assets. 'Tobin Q' is calculated as the market value of equity plus book value of short and long term debt by total assets. 'Facilities per firm' denotes the number of facilities for each firm in each year. 'Green index' is a continuous variable between 0 and 1 with a larger value indicating higher environmental ethics. Total emissions are measured in millions of short tons of CO_2 equivalent. 'Total Assets', 'Net income' and 'Gross Profits' are the firms total assets measured in million USD.

Variable	**Observations**	**Mean**	**Std.Dev.**	**Median**
Total Assets	776	20102.5	20262.48	12714.60
Leverage	789	0.39	0.12	0.36
Capital Intensity	789	0.68	0.12	0.70
Tobin Q	614	1.21	0.16	1.19
Net Income	790	483.11	899.56	301.50
Gross Profit	790	1764.03	1664.407	1132.404
Total Emissions	793	15.14	23.24	4.52
Facilities per firm	793	6.81	8.39	3
Green Index	793	0.028	0.013	0.025

Table 2: Green Index and Emission

This table presents a set of OLS regressions performed on our sample of annual data of companies from EPA's CAMD database for a period between 2001-2020. The dependent variable is the absolute greenhouse gas emissions in billions of short ton of CO_2 equivalent. The primary predictor variable is log of green index. Green index is a continuous variable between 0 and 1 with a larger value indicating higher environmental ethics. Column (1) tabulates the results for facility level data. Column (2) presents the results for regressions at parent level. 'Leverage' is defined as ratio of the total debt to the total assets. 'Tobin Q' is calculated as the market value of equity plus book value of short and long term debt by total assets. 'Capital intensity' is defined as the ratio of plant, property and equipment to total assets. All our regressions control for time and industry fixed effects. Significance at 10%,5% and 1% level is denoted by *, ** and *** respectively. Standard errors, clustered by firm and year for facility level and robust for parent level are shown in parentheses.

	Facility Level (1)	Parent Level (2)
Ln(Green Index)	-0.000	0.006**
	(0.000)	(0.003)
Leverage	0.001**	0.022**
	(0.000)	(0.009)
Ln (Asset Facility)	0.000***	
	(0.000)	
Ln (Asset Parent)		0.018***
		(0.001)
Tobin Q	0.000	0.002
	(0.000)	(0.005)
Capital Intensity	-0.003***	0.078***
	(0.001)	(0.012)
Constant	0.001*	-0.177***
	(0.001)	(0.015)
Observations	5,855	598
R- squared	0.068	0.459
Time FE	YES	YES
Industry FE	YES	YES

Table 3: Environmental Awareness and Scaled Profit (Facility Level)

This table presents a set of OLS regressions performed on our facility level sample of annual data of facilities from EPA's CAMD database for a period between 2001-2020. The dependent variable is scaled_profit defined as the ratio of profit in 000s USD to absolute greenhouse gas emissions in short ton of CO_2 equivalent. The primary predictor variable is log of green index. Green index is a continuous variable between 0 and 1 with a larger value indicating higher environmental ethics. Column (1) tabulates the results with gross profit as the profit measure in scaled_profit. Column (2) uses earnings before interest and taxes (EBIT) as the numerator in the dependent variable. Columns (3) & (4) use earnings before interest, taxes, depreciation &amortisation (EBITDA) and net income as the profit measure respectively. 'Leverage' is defined as ratio of the total debt to the total assets. 'Tobin Q' is calculated as the market value of equity plus book value of short and long term debt by total assets. 'Capital intensity' is defined as the ratio of plant, property and equipment to total assets. All our regressions control for time and industry fixed effects. Significance at 10%,5% and 1% level is denoted by *, ** and *** respectively. Standard errors, clustered by firm and year are shown in parentheses.

	Scaling Variable			
	Gross Profit (1)	EBIT (2)	EBITDA (3)	Net Income (4)
Ln (Green Index)	1.220***	0.768***	1.220***	0.321***
	(0.329)	(0.198)	(0.329)	(0.091)
Leverage	-10.413***	-6.756***	-10.680***	-3.729***
	(1.823)	(1.080)	(1.833)	(0.560)
Ln (Asset)	1.541***	0.923***	1.554***	0.341***
	(0.247)	(0.146)	(0.249)	(0.069)
Tobin Q	0.678	1.080	0.737	0.938**
	(1.394)	(0.811)	(1.392)	(0.399)
Capital Intensity	1.430	1.075	1.433	1.120*
	(2.045)	(1.189)	(2.042)	(0.571)
Constant	-3.287	-2.644	-3.326	-1.239
	(2.846)	(1.723)	(2.863)	(0.805)
Observations	5,855	5,845	5,849	5,855
R-squared	0.080	0.077	0.077	0.067
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

Table 4: Environmental Awareness and Scaled Profit (Company Level)

This table presents a set of OLS regressions performed on our parent level sample of annual data of companies from EPA's CAMD database for a period between 2001-2020. The dependent variable is scaled_profit defined as the ratio of profit in 000s USD to absolute greenhouse gas emissions in short ton of CO_2 equivalent. The primary predictor variable is log of green index. Green index is a continuous variable between 0 and 1 with a larger value indicating higher environmental ethics. Column (1) tabulates the results with gross profit as the profit measure in scaled_profit. Column (2) uses earnings before interest and taxes (EBIT) as the numerator in the dependent variable. Columns (3) & (4) use earnings before interest, taxes, depreciation & amortisation (EBITDA) and net income as the profit measure respectively. 'Leverage' is defined as ratio of the total debt to the total assets. 'Tobin Q' is calculated as the market value of equity plus book value of short and long term debt by total assets. 'Capital intensity' is defined as the ratio of plant, property and equipment to total assets. All our regressions control for time and industry fixed effects. Significance at 10%,5% and 1% level is denoted by *, ** and *** respectively. Robust standard errors are shown in parentheses.

	Scaling Variable			
	Gross Profit (1)	EBIT (2)	EBITDA (3)	Net Income (4)
Ln (Green Index)	0.526	0.414*	0.523	0.119
	(0.427)	(0.221)	(0.426)	(0.116)
Leverage	-15.833***	-9.712***	-16.152***	-5.118***
	(4.030)	(2.386)	(4.086)	(1.149)
Ln (Asset)	-1.541***	-0.743***	-1.538***	-0.373***
	(0.429)	(0.221)	(0.431)	(0.106)
Tobin Q	3.081*	2.053**	2.964	1.362**
	(1.845)	(1.022)	(1.822)	(0.545)
Capital Intensity	-14.143***	-6.906***	-14.023***	-3.297***
	(4.185)	(2.211)	(4.179)	(1.170)
Constant	30.554***	15.093***	30.730***	7.335***
	(7.620)	(3.906)	(7.664)	(1.989)
Observations	598	594	597	598
R-squared	0.462	0.441	0.432	0.296
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

Table 5: Correlation Between Green Index and Refinitiv Ratings

	2002		2020	
	correlation	p_value	correlation	p_value
ESG Emissions Score	0.48	0.02	0.16	0.38
Environment Pillar Score	0.30	0.15	0.03	0.88

Table 6: S&P 500 Companies

This table presents a set of OLS regressions performed on our sample of annual data of S&P 500 companies for a period between 2001-2020. The dependent variable is scaled_profit defined as the ratio of profit in 000s USD to absolute greenhouse gas emissions in short ton of CO_2 equivalent. The primary predictor variable is log of green index. Green index is a continuous variable between 0 and 1 with a larger value indicating higher environmental ethics. Column (1) tabulates the results with gross profit as the profit measure in scaled_profit. Column (2) uses earnings before interest and taxes (EBIT) as the numerator in the dependent variable. Columns (3) & (4) use earnings before interest, taxes, depreciation & amortisation (EBITDA) and net income as the profit measure respectively. 'Leverage' is defined as ratio of the total debt to the total assets. 'Polluter' is a dummy variable which takes a value of '1' for firms with two digit SIC as 29 or 49 and '0'otherwise. 'Tobin Q' is calculated as the market value of equity plus book value of short and long term debt by total assets. 'Capital intensity' is defined as the ratio of plant, property and equipment to total assets. All our regressions control for time and industry fixed effects. Significance at 10%,5% and 1% level is denoted by *, ** and *** respectively. Robust standard errors are shown in parentheses.

	Scaling Variable			
	Gross Profit	EBITDA	EBIT	Net Income
	(1)	(2)	(3)	(4)
Green Index	-0.25^{***}	-0.10^{***}	-0.08^{***}	-0.04^{***}
	(0.04)	(0.02)	(0.02)	(0.01)
Green Index× Polluter	0.26^{***}	0.11^{***}	0.08^{***}	0.05^{**}
	(0.06)	(0.03)	(0.02)	(0.02)
Ln(Asset)	0.0005	0.0004^{***}	0.0002	0.0002^{**}
	(0.0003)	(0.0001)	(0.0001)	(0.0001)
Leverage	-0.004^{*}	-0.001	-0.001	-0.003^{***}
	(0.002)	(0.001)	(0.001)	(0.001)
Capital Intensity	-0.03^{***}	-0.01^{***}	-0.01^{***}	-0.01^{***}
	(0.003)	(0.001)	(0.001)	(0.001)
Tobin Q	0.002^{***}	0.001^{***}	0.001^{***}	0.001^{***}
	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Constant	0.01^{**}	0.003	0.004^{**}	0.001
	(0.005)	(0.002)	(0.002)	(0.001)
Observations	2,124	2,124	2,124	2,124
R^2	0.52	0.50	0.48	0.38
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

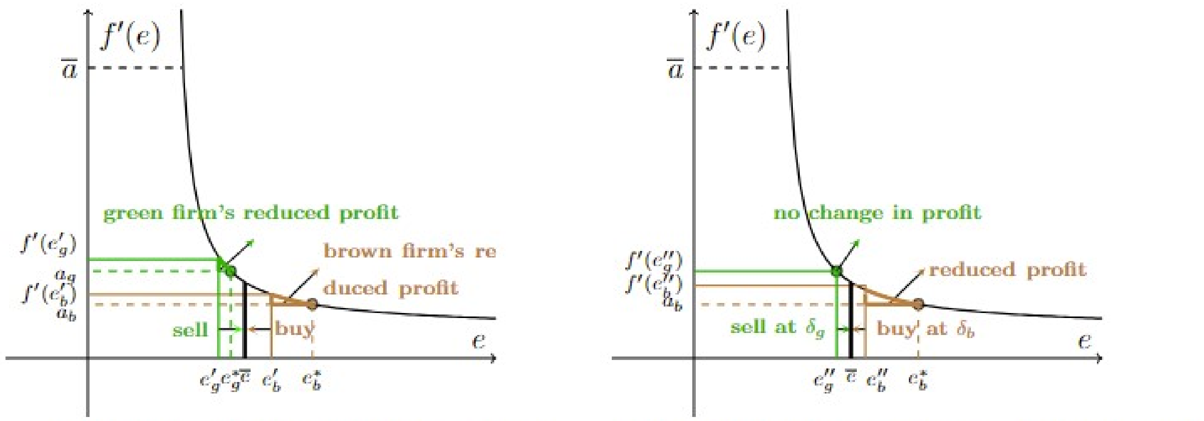
Table 7: Environmental Awareness and Enforcement Cases

This table presents a set of OLS regressions performed on our parent level sample of annual data of companies from EPA's CAMD database for a period between 2001-2020. The dependent variable is scaled_profit defined as the ratio of profit in 000s USD to absolute greenhouse gas emissions in short ton of CO_2 equivalent. The primary predictor variable is cases per year which is defined as the total number of violations at parent level per year reported by Federal Enforcement and Compliance (FE&C). Column (1) tabulates the results with gross profit as the profit measure in scaled_profit. Column (2) uses earnings before interest and taxes (EBIT) as the numerator in the dependent variable. Columns (3) & (4) use earnings before interest, taxes, depreciation & amortisation (EBITDA) and net income as the profit measure respectively. 'Leverage' is defined as ratio of the total debt to the total assets. 'Tobin Q' is calculated as the market value of equity plus book value of short and long term debt by total assets. 'Capital intensity' is defined as the ratio of plant, property and equipment to total assets. All our regressions control for time and industry fixed effects. Significance at 10%,5% and 1% level is denoted by *, ** and *** respectively. Robust standard errors are shown in parentheses.

	Scaling Variable			
	Gross Profit (1)	EBIT (2)	EBITDA (3)	Net Income (4)
Cases per year	-0.403*	-0.183	-0.397*	-0.080
	(0.242)	(0.136)	(0.241)	(0.067)
Leverage	-15.791***	-9.722***	-16.107***	-5.111***
	(4.018)	(2.377)	(4.074)	(1.147)
Ln (Asset)	-1.568***	-0.771***	-1.565***	-0.380***
	(0.447)	(0.234)	(0.449)	(0.109)
Tobin Q	2.804	1.824*	2.688	1.298**
	(1.797)	(1.002)	(1.773)	(0.533)
Capital Intensity	-14.867***	-7.417***	-14.741***	-3.458***
	(4.217)	(2.239)	(4.212)	(1.159)
Constant	29.689***	14.459***	29.867***	7.144***
	(7.418)	(3.777)	(7.463)	(1.960)
Observations	598	594	597	598
R-squared	0.46	0.44	0.43	0.30
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

Figures

Figure 1: Marginal Output and Emission under Government Intervention



(A) Uniform Pricing on Carbon Emission

(B) Scaled-Profit based Pricing on Carbon Emission

Figure 2: Output and Emission Level

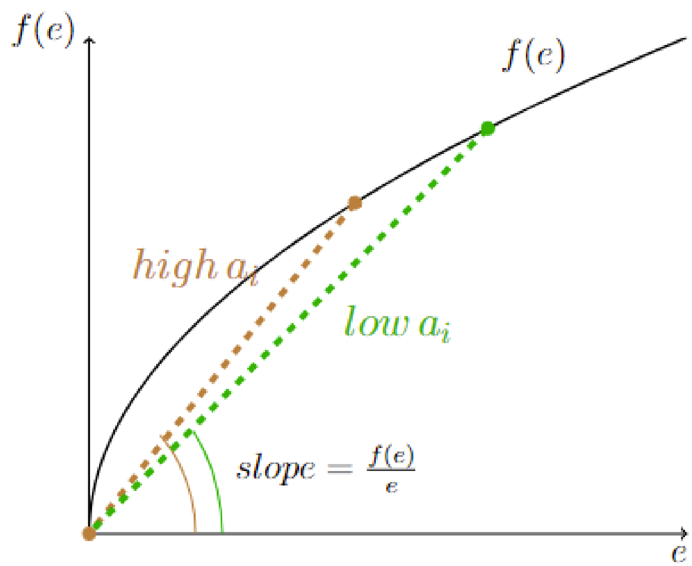


Figure 3: Time Series of Topics

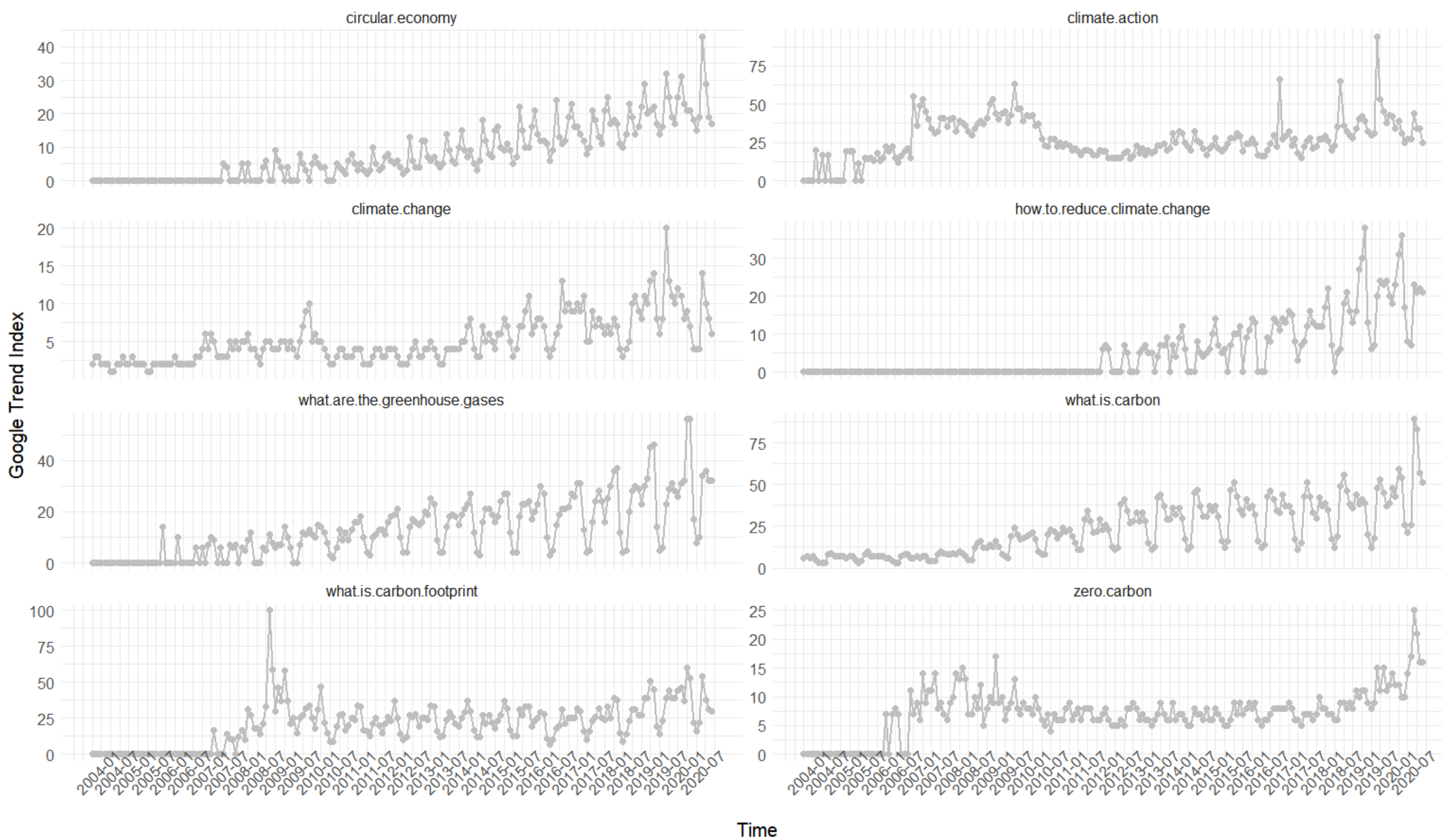
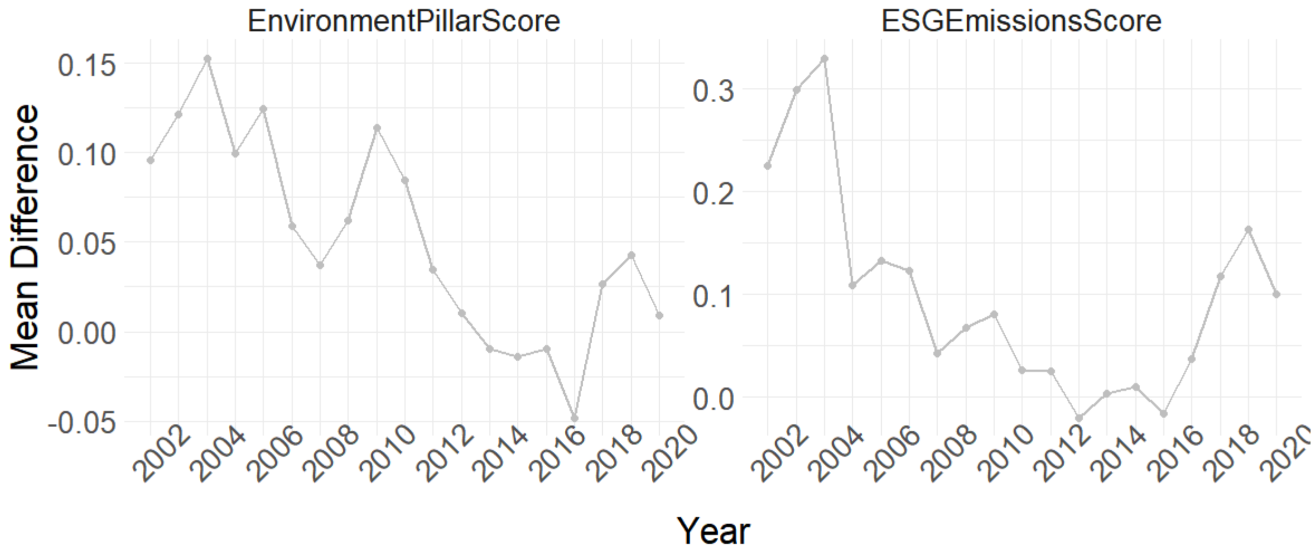


Figure 4: Time Series of Differences in Refinitive Scores

Panel A



Panel B

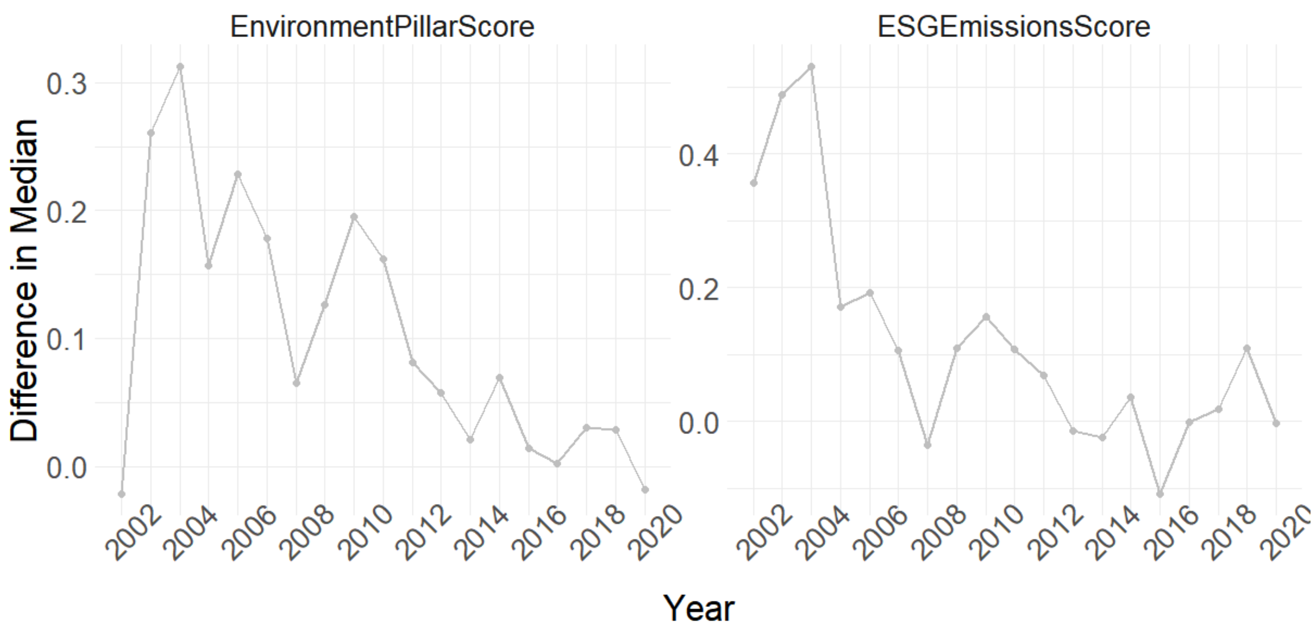


Figure 5: Large Polluting Industries (> 4% Total Emissions)

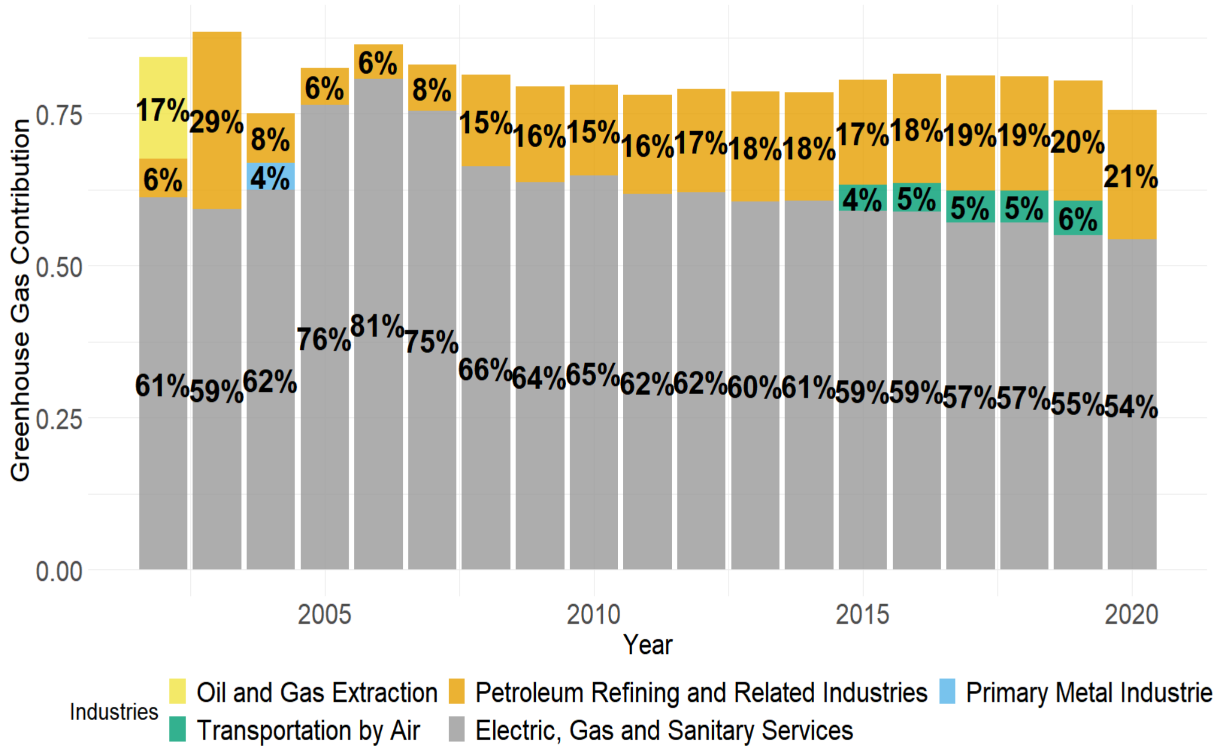
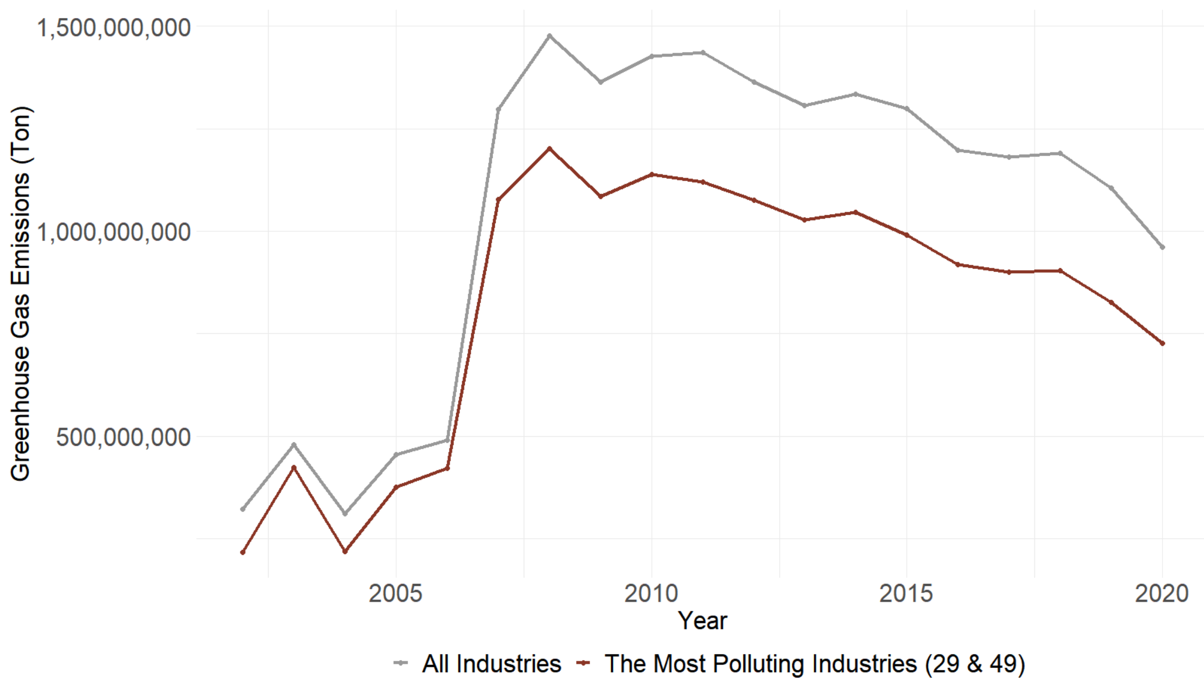


Figure 6: GHG Emissions from Top Polluting Industries vesus All Industries



Appendix

Table A.1: The Dictionary of Environment-Related Keywords

alternative energ	biofuels	biomass	biopower	bioprocess
bioproduct	biodegradable	biodiversity	carbon dioxide	contaminant
contamination	climate change	climate goal	climate action	circular economy
clean energy	clean tech	conservation	deforestation	disposable
decarbon	environmental friendly	ecosystem	emission	energy efficien
extinction	geothermal	ghg	global warming	global temperature
groundwater	green tech	green development	green electricity	green innovation
greenhouse gas	ISO 14000	landfill	ozone layer	paris climate
planet	pollut	recycl	rain forest	renewable energy
reusable	reforestation	solar	sustainabl	toxic
wildlife windmill	wind power	wind energy	wetland	waste
zero carbon				

Table A.2: Trimming Top 5% Environmentally-Conscious Firms

This table presents a set of OLS regressions performed on our parent level sample of annual data of companies from EPA's CAMD database for a period between 2001-2020. The dependent variable is scaled_profit defined as the ratio of profit in 000s USD to absolute greenhouse gas emissions in short ton of CO_2 equivalent. The primary predictor variable is log of green index. Green index is a continuous variable between 0 and 1 with a larger value indicating higher environmental ethics which is trimmed at 5% at right tail. Column (1) tabulates the results with gross profit as the profit measure in scaled_profit. Column (2) uses earnings before interest and taxes (EBIT) as the numerator in the dependent variable. Columns (3) & (4) use earnings before interest, taxes, depreciation & amortisation (EBITDA) and net income as the profit measure respectively. 'Leverage' is defined as ratio of the total debt to the total assets. 'Tobin Q' is calculated as the market value of equity plus book value of short and long term debt by total assets. 'Capital intensity' is defined as the ratio of plant, property and equipment to total assets. All our regressions control for time and industry fixed effects. Significance at 10%,5% and 1% level is denoted by *, ** and *** respectively. Robust standard errors are shown in parentheses.

	Gross Profit (1)	EBIT (2)	EBITDA (3)	Net Income (4)
Ln (Green Index)	0.920*	0.685**	0.916*	0.232
	(0.544)	(0.286)	(0.543)	(0.144)
Leverage	-17.411***	-10.889***	-17.742***	-5.746***
	(4.375)	(2.679)	(4.437)	(1.304)
Ln (Asset)	-1.780***	-0.861***	-1.776***	-0.424***
	(0.505)	(0.262)	(0.507)	(0.122)
Tobin Q	4.074*	2.781**	3.940*	1.725***
	(2.091)	(1.254)	(2.065)	(0.649)
Capital Intensity	-16.317***	-8.148***	-16.178***	-3.881***
	(4.869)	(2.652)	(4.868)	(1.361)
Constant	35.664***	17.788***	35.843***	8.593***
	(8.966)	(4.589)	(9.018)	(2.290)
Observations	547	543	546	547
R-squared	0.47	0.45	0.44	0.30
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

The authors did not use any generative AI or any related tools during the preparation of this work. The authors take full responsibility for the content of the publication.

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