What Gets Unveiled, What Gets Managed:

Reassessing Incentives for Companies to Disclose Carbon Emission Data

by

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 **Abstract**

This essay investigates the mechanism through which the regulatory authorities can incentivize companies to disclose their carbon emissions. Based on the trade-off model established by Adams and Ferreira (2007) in which the board plays the dual role as monitor and advisor to the CEO, we add a third factor, consumer reaction, into the CEO’s decision-making about whether to disclose information. As consumers care about the environmental impacts of their consumption, knowing a company’s emissions will lead them to adjust their purchasing behavior. Our theoretical model shows that companies tend to practice carbon disclosure when their perceived emission level is higher than the actual one. Particularly, when the board’s level of independence is higher and the CEO’s private benefit from project control is smaller, the CEO has more incentives to reveal corporate emission data.

**Keywords:** Carbon Emission; Corporate Information Disclosure; Disclosure Mandate; Voluntary Reporting

# Introduction

In June 2013, the UK Parliament approved the Companies Act 2006 Regulations 2013, requiring publicly listed UK companies to disclose their direct (scope 1) and indirect (scope 2) greenhouse gas (GHG) emissions in their annual financial reports. Scope 1 emissions refer to those produced directly from the company’s activities, such as emissions from fuel combustion when a plastic plant drills for oil. Scope 2 emissions are those emitted by the generation of electricity or heat purchased by the company to provide its products and services. This 2013 disclosure mandate exemplifies the governmental use of public information as a policy instrument in environmental regulation. According to Reichelstein et al (2020), compared to companies that are not subject to this mandate, the affected companies reduced their carbon emissions by 8%. Using different emission datasets and regression models, the studies of Jouvenot and Krueger (2020) and Grewal (2021) also confirm the efficacy of the 2013 disclosure mandate in reducing corporate carbon emissions. Additionally, Tomar demonstrates that a similar US regulation issued in 2010 that obligates large US manufacturing facilities to report their GHG emissions also gave rise to a 7.9% reduction in carbon emissions compared to the counterparts not subject to the regulation (2019). These findings suggest that mandatory disclosure creates an incentive for companies, especially those with a relatively higher level of pre-mandate emissions (Grewal 2021), to reduce their carbon emissions.

Nevertheless, controversy intensifies as the disclosure mandate expands the scopes of emission under coverage. In March 2022, the US Securities and Exchange Commission (SEC) announced plans to require listed companies to disclose their scope 3 emissions, which refer to those caused by activities happening along the company’s entire value chain. For instance, a car company’s scope 3 emissions include emissions from both its upstream component suppliers and downstream car drivers. Scope 3 emissions often take up the largest proportion of a company’s GHG emissions (Huang 2009). Unfortunately, mandating disclosure of scope 3 emissions, as the next step towards a more ambitious carbon reduction roadmap, has encountered legal and technical barriers in addition to resistance from companies. For instance, the existing materiality principle in the US only gives the SEC the authority to request material information of which **“**an average prudent investor ought reasonably to be informed before purchasing the security registered” in companies’ financial reports. Since the definition of “material information” remains open to interpretation, critics of the March proposal, represented by the U.S. Chamber of the Commerce, argue that carbon emission data does not clearly fall under the category of “material information” and thus its publicity should be left to the discretion of companies. More importantly, due to a lack of consistent and reliable accounting standards for scope 3 emissions, companies might under- or over-report their emissions by as much as 50 percent (WSJ 2021). If a company has the intention to tailor its carbon emission data, even regulatory authorities or third-party technical agencies will have difficulty tracing the carbon footprints and verifying the data accuracy. As a result, simply forcing companies to reveal emission data through regulatory pressure may not serve the ultimate goal of achieving carbon neutrality.

How can companies voluntarily unveil their carbon emission data? Answering this question entails an investigation into the mechanism through which information disclosure creates additional benefits. As voluntary emission disclosure constitutes a company’s corporate social responsibility (CSR) activities, this essay builds on the cheap-talk model developed by John et al. (2018) that explores the information value of CSR. Similar to their approach, we model the trade-offs faced by the CEO as an extension of the model set up by Adams and Ferreira (2007) in which the board plays the dual role as a monitor and an advisor to the CEO. According to Adams and Ferreira (2007), revealing information allows the CEO to receive more informative advice from the board in terms of corporate operation but at the same time increases the likelihood that the CEO loses his/her control of the choice of investment projects. In the context of climate change, as investors increasingly account for climate risk in their investment decisions (Krueger et al. 2020), failing to reveal carbon emissions may forfeit funding opportunities and thus cause the board’s distrust of the CEO.

We complicate the original model by adding a third player that the CEO needs to take into account when making decisions: consumers. As consumers care about the environmental impacts of their consumption, knowing a company’s emissions will lead them to adjust their purchase of a company’s products. If a company voluntarily reveals its carbon emission data, we assume that consumers will not only adjust their demand for the company’s products, but also be willing to pay a price premium as the revelation itself signifies the company’s efforts to manage its carbon footprints. In contrast, if a company does not disclose, consumers will view this rejection as a signal of heavy emission and thus decrease their consumption of the company products. Now the CEO faces a trade-off that involves reaction from both the board and consumers. Our theoretical model shows that companies are inclined to practice carbon disclosure when the perceived emission level is higher than the actual one. Particularly, when the board’s level of independence is higher and the CEO’s private benefit from project control is smaller, the CEO has more incentives to reveal corporate emission data.

This remainder of the essay is organized as follows: section 2 reviews relevant literature relating to the use of information in environmental regulation; section 3 establishes the model; section 4 discusses the main observations from modeling and corresponding policy implications; section 5 concludes with a discussion of further research.

# Literature Review

Research on corporate carbon information disclosure adopts both empirical analysis and theoretical modeling. Recent empirical studies confirm the emission-reducing effects of mandatory and voluntary carbon emission reporting. For instance, through comparing companies’ pre-and post-mandate emission levels, Tomar (2019) and Reichelstein et al (2020) illustrate that disclosure mandates have affected companies to curb their GHG emissions by around 8% in the US and UK respectively. Specifically, Grewal (2021) highlights that the 2013 UK mandate has more pronounced emission-reducing effects on companies with a higher level of pre-mandate emissions.

Apart from verifying the emission-reducing effects of carbon emission disclosure, scholars investigate factors that influence companies’ initiative to participate in carbon disclosure and provide high quality data. For example, examining 120 companies from 20 countries, Freedman and Jaggi (2005) discovers that enterprises with a larger size tend to disclose more detailed emission information. Faisal et al. (2018) and Prado-Lorenzo et al. (2009) show that highly profitable companies have more incentives to reveal emission data to stakeholders. In addition, analyzing 494 US enterprises involved in voluntary carbon disclosure in 2007, Stanny and Ely (2008) suggest that companies with a large scale and history of disclosure are more inclined to reveal emission data. Akbaş and Canikli (2019) indicate the correlation between positive corporate reputation and a company’s positivity to emission disclosure. Amran et al. (2014) and Liao et al. (2015) underline a positive correlation between the level of corporate carbon disclosure and the number of independent directors in the board. Focusing on the interactions between companies, Peng et al. (2015) investigate the group effects of information disclosure, arguing that when numerous companies in the same industry unveil emission data, the entire industry tends to practice carbon disclosure. This essay aims to explain several empirical findings from a theoretical perspective. For instance, our modeling results of the strategic competition for consumers between companies provide some insights to understand the group effects illustrated by Peng et al. (2015) as well as the positive correlation between corporate carbon disclosure level and board independence level discovered by Amran et al. (2014) and Liao et al. (2015).

Theoretical literature mainly focuses on unfolding the legitimacy of disclosure mandate and rationality behind voluntary reporting. From the perspective of consumer welfare, Kennedy, et al. (1994) pinpoints the necessity for governmental disclosure mandates due to market failure. From the standpoint of companies, Cho and Patten (2007) argue that in the context of climate change, carbon disclosure gives companies an opportunity to illustrate that their business activities conform to social values, which can alleviate pressure from shareholders, creditors, and social interest groups. Bansal and Roth (2000) also regard information disclosure as an instrument for companies to cope with institutional pressure. Focusing on the effects on company image among consumers, Connelly et al. (2011) indicate that carbon disclosure allows companies to deliver “low-carbon” signals to stakeholders, which can allay investors and consumers’ misgiving caused by information asymmetry. Giannarakis et al. (2018) agree with this effect of reducing information asymmetry through showing how corporate carbon disclosure reduces agency costs. Our model incorporates this feature through a cheap-talk game between the CEO and board. In addition, findings of our theoretical model correspond with the analysis of Verrecchia (1983) which demonstrates that enterprises with good performance tend to voluntarily disclose information due to the difficulty of imitation for competitors with poor performance.

## Model

***3.1 Consumer***

We assume that among all consumers, $t$ of them are environmentally sensitive and each has the below utility function:

$$U\_{i}=x\_{i}z\_{i }-E(θ) \sum\_{i=1}^{t}x\_{i}-E(r) \sum\_{i=1}^{t}z\_{i}$$

$x\_{i}$ is consumer $i$’s consumption of company A’s product $x$, $z\_{i}$ is the consumer $i$’s consumption of company B product $z$. Both companies’ production processes will emit a certain amount of carbon dioxide: the production of each unit of $x$ and $z$ will cause $θ$ and $r $level of carbon emissions. For simplicity, the price of each unit of $x$ is normalized to 1 Each unit of $z$ is sold at price $p$. Each consumer has disposable income $y$. Noteworthily, consumers care about the environmental impacts of their consumption. $\sum\_{i=1}^{t}x\_{i}$ and $\sum\_{i=1}^{t}z\_{i}$ are the aggregate consumption of $x$ and $z$. The environmental damage from consumption, measured by the aggregate emissions, will cause disultily to consumers. Consumers are not sure about the exact value of $θ$ and $r $, but they know that θ $ϵ $[0, $\infty $] with density $f(θ) $and expected value μ while $r ϵ $[0, $\infty $] with density $g(r) $and expected value $λ$. We assume that consumers cannot communicate the exact value of $θ$ and $r $among themselves. In equilibrium, both companies supply their products at marginal cost of production. Namely, $p=c$.

We then characterize consumers’ consumption decisions under four different scenarios where both company A and B decide to disclose emission, only company A or B chooses to reveal, and neither company decides to reveal. Since consumers care about their carbon footprints, we assume that when a company voluntarily practices carbon disclosure, consumers are willing to pay a price premium $ε$ for its products to reward information transparency and support the company’s efforts to curb emissions. In contrast, if a company refuses to reveal, it sends a signal to consumers that the company is emission heavy. As a result, consumers will increase their expectations of the products’ emission level by $τ$. However, if both companies reveal their emission data, consumers will view information disclosure as a common industrial practice and thus will not reward either side by paying a higher price. Let $x$($θ,r)$, $x$($θ,λ)$, $x$($μ,r)$, $x$($μ,λ)$ denote the optimal consumption amount of the company A product $x$ under the above four scenarios respectively. Solving the utility maximization function:

argmax $[x\_{i}(y-px\_{i })-E(θ) \sum\_{i=1}^{t}x\_{i}-E(r) \sum\_{i=1}^{t}(y-px\_{i })]$

we get:

$$x(θ,r)=\frac{r}{2}+\frac{y-θ}{2p} $$

$$x(θ,λ)=\frac{λ+τ}{2}+\frac{y-θ}{2(p-ε)}$$

$$x(μ,r)=\frac{r}{2}+\frac{y-(μ+τ)}{2(p+ε)}$$

$$ x(μ,λ)=\frac{λ}{2}+\frac{y-μ}{2p}$$

We summarize consumers’ optimal consumption in the below matrix:

|  |  |  |
| --- | --- | --- |
|  AB | R | NR |
| R | $$\frac{r}{2}+\frac{y-θ}{2p}$$ | $$\frac{r}{2}+\frac{y-(μ+τ)}{2(p+ε)}$$ |
| NR | $$\frac{λ+τ}{2}+\frac{y-θ}{2[p/(1+ε)]}$$ | $$\frac{λ}{2}+\frac{y-μ}{2p}$$ |

Since company A and B are in a symmetric position, we will analyze the decision about whether to reveal carbon emissions from company A’s perspective.

1. If company B does not reveal its information, disclosing carbon emissions will lead to a change in company A’s revenue by:

$$t[(1+ε)x(θ,λ)-x(μ,λ)]=\frac{t}{2}[(μ-θ)/p+ε(λ+τ)+τ]$$

**Remark**: When company A’s actual carbon emission is lower than consumer perception, the price of company B’s product is lower than that of company A, the price premium paid by consumers is high, and consumer perception of company B’s emission level is high, company A is more inclined to reveal its emission data. The first three observations come as no surprise. Notably, the last observation highlights that when a company knows that its competitor is perceived as a heavy emitter, the company should have more incentive to reveal its emissions even though itself may also produce heavy emissions. This finding suggests that collusive concealment of emission data among heavy emitters is unlikely to be an equilibrium outcome, which is great news for regulators and environmentally sensitive consumers.

1. If company B reveals its information, disclosing carbon emissions will lead to a change in company A’s revenue by:

$$t[x(θ,r)-x(μ,r)]=\frac{t}{2p(p+ε)}[p(μ-θ+τ)+εy-θε]$$

**Remark**: When company A’s actual carbon emission is lower than consumer perception, the price of company B’s product is higher than that of company A, and consumer perception of company A’s emission level is low, company A is more motivated to reveal its emission data. In particular, the last observation demonstrates even when a company is aware of its products’ environmentally friendly reputation, given its competitor’s carbon disclosure practice, the company should reveal its data to increase its competitiveness. This theoretical observation corresponds with the empirical finding by Peng et al. (2015) stating that when numerous companies in an industry unveil emission data, the entire industry becomes inclined to practice carbon disclosure. Our theoretical model partially explains the rationality behind this group effect.

Let $G(μ,θ,p,ε)$ and $F$($μ,θ,p,ε,λ)$ denote the change in company A’s pre- and post-disclosure revenue given company B does and does not reveal its emission data. In the next subsection, we will consider this potential revenue gain or loss within the framework of friendly rivalry between the CEO and board.

***3.2 Company CEO and board***

We consider the game between the CEO and the board of company A based on the model established by Adams and Ferreira (2007). The board plays a dual role in corporate management: advisor and monitor of the CEO. Company A is established at date 0 and the shareholders appoint the CEO and board. $I ϵ [0,1] $captures the independence level of the board, which measures the extent to which the interest of the board is immune to the CEO’s impacts. Only the CEO has access to the company’s exact level of carbon emission $θ$. At date 1, the CEO decides whether to reveal $θ$ to the board. If the CEO reveals $θ$, the board will obtain its private information $ϕ$ about emission risk. If the CEO refuses to reveal, the board can only maintain its prior belief over the distribution of $ϕ$, a uniform distribution between 0 and 1. At date 2, the board will choose its monitoring intensity $π ϵ [0,1]$. This monitoring intensity determines the probability that the board takes control of the choice of company investment project at date 3. If the CEO ends up having the final say in project choice, the board will send its advice $a$ to the CEO about climate risk management based on its private information $ϕ$. With the subscripts $c$ and $b$ denoting the CEO and board respectively, their utility functions are:

$U\_{c}=-(y-ε-g)^{2}+βχ $

$$U\_{b}=-\left(y-ε\right)^{2}-C(π; I) $$

where $y$ denotes the chosen project, $g>0$ measures the difference in the CEO and board’s interest. For simplicity, the maximum profit is normalized to zero. Parameter $β>0$ measures the CEO’s private benefits of remaining control over the project choice. $χ$ is a dummy variable such that $χ =1$ when the CEO remains control and $χ =0$ when the board has the final say on the choice of project. We also assume that the board’s monitoring cost function is quadratic:

$$C(π; I)=\frac{π^{2}}{2I}$$

When the board chooses to monitor the CEO more intensively, it needs to spend more time and energy. A more independent board can carry out monitoring in a less costly way as its interest does not overlap much with that of the CEO.

*A. The Board’s Advice at Date 3*

According to Adams and Ferreira (2007), when the CEO controls the choice of project and the board obtains its private information $ϕ$ about climate risk, there exists at least one Bayesian Nash equilibrium in this advising game: given the advising rule $q(a | ϕ)$, for a positive integer $N$ that can defines a set of $N+1$ real numbers, with generic element denoted by $a\_{i}$, such that$0=a\_{0}<a\_{1}<...<a\_{N-1}<a\_{N}=1$,

(a) $y(a)=\frac{a\_{i+1}+ a\_{i}}{2}-g$ for all$ a \in (a\_{i},a\_{i+1})$ and

(b) $q(a | ϕ)$ is uniformly distributed on $[a\_{i},a\_{i+1}]$ if $ε \in (a\_{i},a\_{i+1})$.

This outcome, following from Theorem1 in Crawford and Sobel (1982), indicates that at equilibrium, the board intentionally distorts its advice by adding noise to it. Namely, the CEO only learns that $ϕ$ lies in the interval $(a\_{i},a\_{i+1})$ instead of $ϕ$’s exact value. Knowing the board’s advising strategy, the CEO thus chooses project $y(a)=\frac{a\_{i+1}+a\_{i}}{2}-g$ to maximize his/her expected utility. Let $σ\_{ε}^{2}$ denote the residual variance of $ϕ$ that the CEO has after receiving advice from the board. Based on the equilibrium result from Crawford and Sobel (1982), we get:

 $σ\_{ε}^{2}=\frac{1}{12N^{2}}+\frac{g^{2}(N^{2}-1)}{3}$

where $N$ is the smallest integer greater or equal to $\hat{N}$ and

 $\hat{N}=-\frac{1}{2}+\frac{1}{2}\sqrt{1+\frac{2}{g}}$

Since the board’s advice is more informative as $N $increases, the residual variance is maximized

when $N=1$, reaching its maximum value $σ\_{M}^{2}=\frac{1}{12}$.

B. *The Board’s Monitoring Intensity at Date 2*

 Let $i$ denote the information the board obtains from the CEO regarding θ. When the CEO reveals $θ$, $i=θ$. When the CEO refuses to reveal, $i=ø$. A board that knows $θ$ will choose the monitoring intensity that maximizes its expected utility:

$$πE[-(y\_{b}-ε)^{2}|i=θ ]+(1-π)E[-(y(a)-ε)^{2}]-\frac{π^{2}}{2I}$$

Solving the function, we get the optimal monitoring intensity $\overline{π} $for an informed board is:

$$\overline{π}=I(σ\_{ε}^{2}+g^{2})$$

Correspondingly, the optimal monitoring intensity $\hat{π} $for an uninformed board is:

$$\hat{π}=Ig^{2}$$

The optimal monitoring intensity of an informed board is larger than that of an uninformed board. This result corresponds to the underlying assumption that a more informed board will monitor the CEO more intensively.

C. *The CEO’s Decision to Reveal* $θ $*at Date 1*

We now analyze the CEO’s decision about whether to reveal emission level $θ$ when he/she knows the optimal level of monitoring intensity the board will choose in two scenarios. If the CEO reveals $θ$ to the board, the CEO’s expected utility $EU\_{c}(i=θ;I)$ is:

$$π(i=1;I)E[-(y\_{b}-ε-g)^{2}|i=θ ]+(1-π)\{E[-(y(a)-ε-g)^{2}|i=θ]+b\}$$

If the CEO refuses to reveal $θ$ to the board, the CEO’s expected utility $EU\_{c}(i=ø;I)$ is:

$$-π(i=ø;I)(σ\_{ε}^{2}+g^{2})-[1-π(i=ø;I)] (σ\_{M}^{2}-β)$$

Hence, the CEO will choose to reveal the emission level $θ $to the board if and only if:

$$EU\_{c}(i=θ;I)-EU\_{c}(i=ø;I) =σ\_{M}^{2}-σ\_{ε}^{2}+Iσ\_{ε}^{2}(σ\_{ε}^{2}-β)\geq 0 $$

The above condition function describes the trade-off the CEO faces. $σ\_{M}^{2}-σ\_{ε}^{2}$ measures the advisory benefits the CEO can receive from revealing emission level $θ$. If the board remains uninformed of $θ$, the residual variance the CEO has about $ϕ $after receiving the board’s advice from the board will reach $σ\_{M}^{2}$, its maximum value. $βIσ\_{ε}^{2}$ measures the CEO’s expected loss from revealing emission data. When the board has more information regarding $θ$, as illustrated in part B, it will increase its monitoring intensity and thus has a higher likelihood to take control of the final choice of investment project.

### Analysis and Implications

In this section, we will complicate the Adams and Ferreira (2007) model by adding the effects of consumer reaction towards carbon disclosure in the CEO’s decision-making. According to section 3, $G(μ,θ,p,ε)$ and $F$($μ,θ,p,ε,λ)$ denote the change in company A’s pre- and post-disclosure revenue given company B does and does not reveal its emission data:

$$G(μ,θ,p,ε)=\frac{t}{2p(p+ε)}[p(μ-θ+τ)+εy-θε]$$

$F$($μ,θ,p,ε,λ)=\frac{t}{2}[(μ-θ)/p+ε(λ+τ)+τ]$

Hence, the CEO of company A will choose to reveal carbon emission data if$σ\_{M}^{2}-σ\_{ε}^{2}+Iσ\_{ε}^{2}(σ\_{ε}^{2}-β)+G(μ,θ,p,ε)\geq 0$ when company B discloses its data; $σ\_{M}^{2}-σ\_{ε}^{2}+Iσ\_{ε}^{2}(σ\_{ε}^{2}-β)+F(μ,θ,p,ε,λ)\geq 0$ when company B refuses to disclose.

*PROPOSITION 1* *When the board’s level of independence* $I$ *is high and the CEO’s private benefits of remaining control over the project choice*$ β$ *is small, the CEO is more motivated to reveal the company’s emission data.*

Let $φ(σ\_{ε}^{2})$ denote the trade-off condition function the CEO faces, where $σ\_{ε}^{2}ϵ (0, \frac{1}{12}]$.

$φ(σ\_{ε}^{2})=$ $σ\_{M}^{2}-σ\_{ε}^{2}+Iσ\_{ε}^{2}(σ\_{ε}^{2}-β)+G(μ,θ,p,ε)$

$$φ(σ\_{ε}^{2})=σ\_{M}^{2}-σ\_{ε}^{2}+Iσ\_{ε}^{2}(σ\_{ε}^{2}-β)+F(μ,θ,p,ε,λ)$$

Since $σ\_{ε}^{2} ϵ (0, \frac{1}{12}]$ and $\frac{β}{2}+\frac{1}{2I}>\frac{1}{12}$, $φ(σ\_{ε}^{2})$ reaches its minimum value when $σ\_{ε}^{2}=\frac{1}{12}$. When $φ(σ\_{ε}^{2})$ is at its minimum value $\frac{I}{12}(\frac{1}{12}-β)$, if the board is more independent and the CEO’s private benefit of remaining control over the project choice$ β$ is smaller, the minimum value will be higher. This result corresponds to the empirical findings by Amran et al. (2014) and Liao et al. (2015) which demonstrate a positive correlation between a high level of corporate carbon disclosure and independent directors in the board.

### PROPOSITION 2 Assuming $β$ is a linear function of $G(μ,θ,p,ε)$ and$ F(μ,θ,p,ε,λ)$, as potential revenues from disclosing carbon emissions increase, it is unlikely that the CEO will never choose to reveal the corporate emission level $θ$.

To make $β$ endogenous, we assume that the CEO derives part of his/her private benefit of remaining control over projects from the company’s revenues. For simplicity, we assume $β$is a linear function of $r$:

$β=αG(μ,θ,p,ε)+k$ when company B discloses its data

$β=αF(μ,θ,p,ε,λ)+k$ when company B refuses to disclose

where $α ϵ (0,1)$ measures the fraction of revenue that constitutes the CEO’s private benefits. When $max\{G(μ,θ,p,ε),F(μ,θ,p,ε,λ)\}\leq min[-I(σ\_{ε}^{2})^{2}+(βI+1)σ\_{ε}^{2}-\frac{1}{12}]$, the CEO will never choose reveal $θ. $The above condition function can be rearranged as:

$$max\{G(μ,θ,p,ε),F(μ,θ,p,ε,λ)\}\leq \frac{α}{12}max\{G(μ,θ,p,ε),F(μ,θ,p,ε,λ)\}+\frac{k}{12}-\frac{I}{144}$$

When the revenue from revealing carbon emission increases continuously, especially when $max\{G(μ,θ,p,ε),F(μ,θ,p,ε,λ)\}>\frac{k-\frac{I}{12}}{12-α}$, the above condition will no longer hold. Hence, the CEO is unlikely to always conceal the company’s emission data.

In light of the current controversy over whether scope 3 emission constitutes “material information” for investors, the findings of our model can provide new insights for the role of regulatory authorities in providing public environmental information. In the context of carbon emissions, regulators are not in the same advantageous position as company CEOs to possess accurate emission data. Enforcing carbon disclosure mandates in this scenario will demand considerable investment in supporting measures such as credible data monitoring, reporting, and verification (MRV) mechanisms. Hence, regulators can consider leveraging the group effect discovered by Peng et al. (2015) through turning their policy focus to incentivizing voluntary carbon disclosure. For instance, as companies with a higher level of board independence are more likely to reveal emission data, regulators can push for reforms in corporate laws regarding board election and corporate governance to increase the board’s independence level. In addition, since companies tend to unveil emission data when their perceived emission level is higher than the actual one, regulators can also cultivate consumers’ environmental consciousness through public education and public service advertising. More importantly, promoting voluntary disclosure will encourage the participation of multiple stakeholders and social interest groups, which can thus expand regulators’ social influence. For instance, regulators can recommend or oblige central banks and financial institutions to incorporate environmental considerations into their financing decision-making. Failing to disclose emission data will devalue a company’s eligible collateral assets and thus jeopardize its ability to borrow at a favorable interest rate. Previous theoretical studies have investigated the financial impacts of corporate carbon disclosure. For instance, revealing carbon emission data enables companies to avoid investors’ adverse selection, which can promote the efficient allocation of resources in the overall capital market (Clarkson et al. 2008) through reducing the capital costs of efficient companies (Dhaliwal et al. 2011).

1. **Conclusion**

Corporate carbon emission has been an obstacle to combating climate change. In the U.S., carbon emissions from commercial and industrial sources were three times the emissions from residential sources in 2010 (U.S. Environmental Protection Agency, 2012). To improve corporate emission management, several countries have implemented mandatory carbon disclosure as a “climate” version of using public information in environmental regulation. For instance, the U.S. required all facilities that emit more than 25,000 metric tons to disclose their emissions (U.S. Environmental Protection Agency, 2012). In the UK, publicly listed companies must include their aggregate GHG emissions in their annual financial reports (U.K. Government, 2013). At the same time, the debate over appropriate nature and scope of public information provision has never cooled off. Although the EU attempted to legitimize the disclosure of corporate carbon emission with the concept of double materiality,[[1]](#footnote-1) it still fudged on the criteria of “materiality”.

Given this dilemma, our theoretical model explores the feasibility of using voluntary emission disclosure as a more comfortable and achievable alternative to straight disclosure mandates. Our modeling of consumer response towards carbon disclosure shows that when competitors refuse to reveal emission data and their products are sold at a lower price, a company will tend to disclose emissions even if the competitors are perceived as heavy emitters. This result demonstrates the achievability of promoting voluntary carbon disclosure among heavy emitters as they are not likely to collusively conceal emission data. In contrast, when competitors disclose first and price their products at a higher level, a company has the motivation to disclose as well despite its established environmental reputation. This theoretical finding is in line with an empirical analysis by Peng et al. (2015) which illustrates the group effect in carbon disclosure. Our modeling of the trade-off faced by the CEO highlights corporate features that induce the CEO to practice carbon disclosure. Specifically, when the board’s level of independence is higher and the CEO’s private benefit from project control is smaller, the CEO has more incentives to reveal data.

Further research on theoretical modeling of voluntary corporate carbon disclosure can consider the following directions. Our model assumes the homogeneity among consumers and alignment of interests among members of the board. However, consumers usually have different perceptions about a company’s emission level and show different levels of responsiveness when adjusting their purchase. Correspondingly, members of the board have different preferences over choice of projects. A more sophisticated model can explore the impacts of this heterogeneity on the potential revenues from revealing information as well as the quality of advice the CEO receives. In addition, our model only considers the decision the company CEO faces as whether to reveal corporate carbon emissions. Nevertheless, in reality, the CEO can choose which part of information to reveal and to what extent to reveal data. A closer examination can allow the CEO to have multiple options when practicing carbon disclosure.

For simplicity, our model treats the price premium $ε $consumers are willing to pay for companies that voluntarily reveal their emissions as an exogenous variable. A proximate evaluation of this price premium can be the difference between the expected utility of an informed and uninformed consumer, which correlates with consumer perceptions of corporate emission level $θ$. If we follow this approach, revealing emission data in some cases may decrease consumer welfare, especially when consumers are pessimistic and perceive the emission level higher than actual one. Given such negative impacts on consumers, whether regulators should still enforce or encourage information disclosure remains an open question.

# References

Adams, R. B., Ferreira, D. (2007). “A Theory of Friendly Boards,” *The Journal of Finance*, 62(1): 217–250. <http://www.jstor.org/stable/4123461>

Akbaş H, Canikli S. (2019). “Determinants of Voluntary Greenhouse Gas Emission Disclosure: An Empirical Investigation on Turkish Firms,” *Sustainability*, 11(1): 107.

Amran A, Periasamy V, Zulkafli A H (2014). “Determinants of climate change disclosure by developed and emerging countries in Asia Pacific,” *Sustainable Development*, 22(3): 188–204

Bansal P, Roth K (2000). “Why Companies Go Green: A Model of Ecological Responsiveness,” *Academy of Management Journal*, 43(4): 717–736

Cho C H, Patten D M (2007). “The Role of Environmental Disclosures as Tools of Legitimacy: A Research Note,” *Accounting, Organizations and Society*, 32(7–8): 639–647.

Clarkson P M, Li Y, Richardson G D, Vasvari F P (2008). “Revisiting the Relation between Environmental Performance and Environmental Disclosure: An Empirical Analysis,” *Accounting, Organizations and Society*, 33(4–5): 303–327.

Connelly B L, Certo S T, Ireland R D, Reutzel C R (2011). “Signaling Theory: A Review and Assessment,” *Journal of Management*, 37(1): 39– 67.

Dhaliwal D S, Li O Z, Tsang A, Yang Y G (2011). “Voluntary Nonfinancial Disclosure and the Cost of Equity Capital: The Initiation of Corporate Social Responsibility Reporting,” *Accounting Review*, 86(1): 59–100.

Eaglesham, J. (2021). “Companies Are Tallying Their Carbon Emissions, but the Data Can Be Tricky,” *The Wall Street Journal*. https://www.wsj.com/articles/companies-are-tallying-their-carbon-emissions-but-the-data-can-be-tricky-11630661401.

Faisal F, Andiningtyas E D, Achmad T, Haryanto H, Meiranto W (2018). “The Content and Determinants of Greenhouse Gas Emission Disclosure: Evidence from Indonesian Companies,” *Corporate Social Responsibility and Environmental Management*, 25(6): 1397–1406.

Freedman M, Jaggi B (2005). “Global Warming, Commitment to the Kyoto Protocol, and Accounting Disclosures by the Largest Global Public Firms from Polluting Industries,” *International Journal of Accounting*, 40(3): 215–232.

Giannarakis G, Zafeiriou E, Arabatzis G, Partalidou X (2018). “Determinants of Corporate Climate Change Disclosure for European Firms,” *Corporate Social Responsibility and Environmental Management*, 25(3): 281–294.

Grewal, J. (2021). “Real Effects of Disclosure Regulation on Voluntary Disclosers,” *Journal of Accounting and Economics*. <https://doi.org/10.1016/j.jacceco>.

Huang, Y. A., Lenzen, M., Weber, C. L., Murray, J., & Matthews, H. S. (2009). “The role of input–output analysis for the screening of corporate carbon footprints,” *Economic Systems Research*, 21(3), 217-242.

John, Kose and Lee, Jongsub and Oh, Ji Yeol Jimmy. (2018). “The Information Value of Corporate Social Responsibility,” Proceedings of Paris December 2019 Finance Meeting EUROFIDAI - ESSEC, Available at SSRN: http://dx.doi.org/10.2139/ssrn.3119039.

Jouvenot, V., and P. Krueger. (2020). “Reduction in Corporate Greenhouse Gas Emissions Under Prescriptive Disclosure Requirements,” Available at SSRN: http://dx.doi.org/10.2139/ssrn.3434490.

Kennedy et al. (1994). “Pollution Policy: The Role for Publicly Provided Information,” *Journal of Environmental Economics and Management*, 26:31- 43. http://doi.org/10.1006/jeem.1994.1003.

Krueger. P, Sautner. Z, Starks. L. (2020). “The Importance of Climate Risks for Institutional Investors,” *The Review of Financial Studies*, 33(3): 1067–1111, https://doi.org/10.1093/rfs/hhz137.

Liao. L, Luo. L, Tang Q. (2015). “Gender Diversity, Board independence, Environmental Committee and Greenhouse Gas Disclosure,” *British Accounting Review*, 47(4): 409–424.

Peng J, Sun J, Luo R (2015). “Corporate Voluntary Carbon Information Disclosure: Evidence from China’s Listed Companies,” *World Economy*, 38(1): 91–109.

Prado-Lorenzo J M, Rodríguez-Domínguez L, Gallego-Álvarez I, García-Sánchez I M (2009). “Factors Influencing the Disclosure of Greenhouse Gas Emissions in Companies Worldwide,” *Management Decision*, 47(7): 1133–1157.

Reichelstein, Stefan J. et al. (2020). “The Impact of Carbon Disclosure Mandates on Emissions and Financial Operating Performance,” ZEW - Center for European Economic Research Discussion Paper No. 20-038, http://dx.doi.org/10.2139/ssrn.3693670.

Stanny E, Ely K (2008). “Corporate Environmental Disclosures about the Effects of Climate Change,” *Corporate Social Responsibility and Environmental Management*, 15(6): 338–348.

Tomar, S. (2021) “Greenhouse Gas Disclosure and Emissions Benchmarking,” SMU Cox School of Business Research Paper No. 19-17, European Corporate Governance Institute – Finance. No. 818/2022, <http://dx.doi.org/10.2139/ssrn.3448904>.

Verrecchia R E (1983). “Discretionary Disclosure,” *Journal of Accounting and Economics*, 5:179–194.

U.K. Government. (2013). The Companies Act 2006 (Strategic Report and Directors’ Report) Regulations 2013. London, England: The Stationery Office.

U.S. Environmental Protection Agency. (2012). Inventory of U.S. greenhouse gas emissions and sinks: 1990-2019. Washington, DC.

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1. The concept of double materiality states that material corporate information includes not only information that illustrates a company’s financial value, but also information of a company’s impacts on the general social welfare, particularly regarding climate change and environment. [↑](#footnote-ref-1)