# Environmental Legislation, Emissions and Emissions Disclosures – A multinational study

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**Abstract**

This study draws on stakeholder theory to investigate the relationship between environmental legislation (both mandated and voluntary) and greenhouse gas emissions for the top 100 largest global emitters as identified by the Carbon Disclosure Project (CDP). Using a sample of 505 observations, we find that:
i) mandated environmental disclosure legislation has an inverse association with greenhouse gas emissions, ii) voluntary environmental disclosure legislation does not have any association with greenhouse gas emissions, iii) neither mandated nor voluntary environmental disclosure legislation has an association with corporate environmental disclosures, and iv) Kyoto agreement ratification is positively associated with corporate environmental disclosures. These findings are consistent with stakeholder theory, which predicts organisations use of strategy to manage stakeholder expectations.

**Keywords:** Environmental legislation; Voluntary Disclosure; Environmental Disclosures; Greenhouse Gas Emissions.

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## 1. Introduction

There has been increased stakeholder awareness of environmental issues and demand for better environmental performance and increased transparency on environmental issues such as greenhouse gas (GHG) emissions to be delivered by the corporate sector. This awareness has been fuelled by various regulatory developments nationally and internationally. Importantly, organisations' attempts to meet stakeholders' expectations of reduced emissions and to comply with emission regulations and carbon reporting frameworks have become a part of governance, strategy and risk management in many organisations. Agreements, such as the Kyoto Protocol and Paris Climate Agreement, have resulted in various national pieces of legislation which significantly changed the landscape to motivate better GHG emission performance and transparency by the corporate sector. Investors have started showing increased attention to the corporate disclosure of climate change risks (Solomon, Solomon, Norton, & Joseph, 2011).

The national context and environmental legislation are associated with improved carbon performance and disclosure by companies operating in countries that mandate (Chelli, Durocher and Fortin, 2018; Grauel and Gotthardt, 2016; Freedman and Jaggi, 2005). Utilising the Carbon Disclosure Project (CDP) as a common platform for global companies to report on the topic of climate change, this study investigates the carbon performance and CDP disclosure of companies from different national contexts with mandatory or voluntary regulations.

Previous theoretical work and empirical studies provide evidence that stakeholder demand has improved GHG emission disclosures (Arena, Bozzolan, and Michelon, 2015; Liu and Anbumozhi, 2009; Haque, Deegan, and Inglis, 2016; Kraft, 2018). Haque, et al. (2016) noticed a lower level of disclosure attributable to a lack of proactive stakeholder engagement.

Empirically, we focus on national environmental regulations that focus on corporate disclosure of GHG emissions in the form of both mandatory and voluntary adoption, and their impact on GHG emissions and the environmental disclosure score. Our results indicate that organisations affected by mandated environmental legislation have comparatively lower levels of greenhouse gas emissions compared with those in countries that do not have such legislation. However, this does not apply to companies in countries that fall under voluntary environmental legislation, and the results suggest that legislation needs to be mandatory regulation for better carbon performance. In the case of corporate GHG emission disclosure, neither mandatory nor voluntary regulation influences disclosure, while Kyoto Protocol membership is found to have a positive relationship with GHG emission disclosure.

The study contributes to the debate concerning the corporate role in climate change in two ways. We add to the literature on the relationship between legislation in two forms, based on its nature- mandatory or voluntary, and its impact on both carbon performance and disclosure, which has not been the focus of research in prior studies.

## 2. Theoretical framework and literature review

### *2.1 Theoretical framework: Stakeholder theory*

In his book 'A Stakeholder Approach' Freeman (1984) defines stakeholders as: *"Any group or individual who can affect or is affected by the achievements of the firm's objectives"* (Freeman, 1984, cited in Roberts, 1992, p.597). Roberts (1992) states that social disclosures are tools to manage this stakeholder relationship. Deegan (2002) notes that the stakeholder theory focuses on different "stakeholders" that make up the society and the organisation's relation to them. Hasnas (1998) states that the meeting of stakeholder obligations is achieved through two

principles; i) the principle of corporate legitimacy, where corporations should be managed to meet the benefits of all stakeholders, and ii), the principle of stakeholder fiduciary obligation, where managers have a fiduciary responsibility to all stakeholders and must act in the interest of all stakeholders (Hasnas, 1998).

Stakeholders such as customers, employees, suppliers, management, and the local community are vital to the existence and success of the firm, and the interests of different stakeholders will be different. Stakeholder theory is one of the leading theories supporting business ethics, and its premise is that all stakeholders should be considered by a firm (Freeman, 1984). A firm's policies are to be under consideration with all stakeholders in mind, and they should seek to maintain an optimal balance among stakeholders while maximising the firm's financial goals. According to Harrison et al. (2015), stakeholder theory is useful in addressing important issues concerning business from an international perspective.

Stakeholder theory sets distinct stages to measure corporate social performance by distinguishing between social issues and stakeholder issues (Clarkson, 1995). Voluntary environmental disclosure by companies is a response to the existence of stakeholders who are interested in the behaviour of a company (Freeman, 1984) concerning environmental issues. Similarly, corporate GHG emission disclosure represents a response to stakeholder demand for more transparency on climate change as a pressing societal issue. Stakeholder theory is different from legitimacy theory in that it concentrates on the expectations of particular interest groups, while legitimacy theory focuses on the expectations of society in general. Stakeholder theory considers an organisation to be part of the social system consisting of several groups working together to achieve common goals. The organisational goals can be achieved successfully when the interests of all its stakeholders are considered. Stakeholder power and the firm's strategic posture have a significant influence on managerial behaviour (Jaggi, Allini, Macchioni & Zagaria, 2017).

### *2.2. Empirical literature on environmental legislation, emissions, and emission disclosures*

Several studies examine the influence of institutional pressure on corporate disclosure of GHG emissions (see, for instance, Nonna Martinov-Bennie (2012) and Thistlethwaite (2015)). Nonna Martinov-Bennie (2012) saw the evolution of more rigorous GHG reporting-related governance frameworks and management systems that cater for the introduction of a carbon pricing mechanism, its relationship with corporate financial performance, and increased risks associated with inaccurate reporting. Thistlethwaite (2015) studied the emergence of the Climate Disclosure Standards Board (CDSB) and the way it uses accounting expertise to shape climate change risk reporting.

In a study of the effects of climate change regulations on business, Tsalis and Nikolaou (2017) developed a simulation model for managing the business risks derived from climate change. The study found that companies can improve their profitability and reduce the carbon dioxide per product. Patchell (2018) explains why the management of scope 3 emissions is less successful compared to the GHG Protocol's scope 1 and 2 recommendations in gaining compliance. Scope 3 emissions are more complicated than the other two as it takes into consideration the full audit of value chain emissions. Transaction costs, power, responsibility allocation, uncertainty, location contingency, and production costs were identified as factors that obstruct widespread adoption of scope 3 emission reporting. In a study of the indirect impact of carbon pricing and adoption of GRI and ISO 14001 on voluntary environmental disclosures, Rahman, Khan, and Siriwardhane (2019) found that there is an indirect

institutional impact (GRI and ISO 14001 certification) of carbon pricing on the quality of voluntary environmental disclosures, which supports the institutional theory.

Cohen and Santhakumar (2007) studied mandatory disclosure regulations and their impact on firm behaviour in terms of the level of pollution, the costs and benefits of these programs, and whether or not they enhance social welfare. The study presented a simple bargaining model explaining that mandatory information disclosure is used to overcome a lack of information on the part of the public.

Evangelinos, Nikolaou and Leal Filho (2015) provide a framework to explain how climate change policy impacts corporate environmental strategies. The study suggests that environmental strategy can be translated into an integrated environmental accounting model based on formal accounting statements. Climate change disclosure by electric utilities in relation to stakeholder power in a regulated market was studied by Kraft (2018), who found that shareholder pressures do not result in greater disclosure. However, when markets become more competitive, shareholder pressure results in greater disclosure. Bowen, Tang and Panagiotopoulos (2019) studied information based on mandatory and voluntary regulations and whether disclosures reveal compliance or beyond compliance performance behaviours.

Hsueh (2019) studied Global 500 firms disclosures about climate change and how much information is disclosed. The existence of senior managers, executive-level officers and the adoption of environmental, social and governance (ESG) principles were significant drivers of participation in voluntary carbon disclosure. Elijido-Ten and Clarkson (2019) studied the differences in responses of firms recognized as superior sustainability performers. Using content analysis of disclosures by the world's largest 500 firms, the study noted a greater awareness of physical and other climate change opportunities is making firms superior performers. Firms with superior performance provide a more detailed description of climate change strategies. Freedman and Jaggi (2005) studied the extent of GHG emissions and pollution found higher disclosure by firms from countries that ratified the Kyoto Protocol compared to firms in other countries.

In the context of a chemical leak at Union Carbide's plant at Bhopal, India in 1984, Patten and Trompeter (2003) studied the relation between the level of environmental disclosure before the event and the extent of earnings management by 40 US chemical firms in response to a regulatory threat. Management appeared to believe that environmental disclosure is an effective tool for reducing exposure to potential regulatory costs. Matisoff (2012) studied how companies address carbon emissions under voluntary environmental programs by studying two private voluntary initiatives for carbon management and disclosure: the Chicago Climate Exchange (CCX) and the CDP. An analysis of firms that participate or not in these programmes found that the CDP is not associated with a decrease in carbon emissions, and program participation is associated with an increase in carbon dioxide intensity.

Stanny (2013) studied the voluntary disclosures of GHG emissions by US S&P 500 firms to CDP. Information on the volume of emissions or how they account for them was not disclosed by many firms, which supports the findings of prior studies on legitimacy theory that firms disclose the minimum to avoid scrutiny. Blanco, Caro and Corbett (2016) studied the state of scope 3 emissions (supply chain carbon emission) using CDP disclosures by US firms. An approach was developed to evaluate scope 3 carbon emissions disclosure based on Environmental Input-Output Life-Cycle Assessment models and found that although firms are beginning to account for an increasing portion of their supply chain's carbon emissions, there is substantial room for improvement in their measurement and disclosure of scope 3 emissions. Scope 3 emissions reporting varies widely across industries.

Peters and Romi (2013) found that firms are more likely to provide mandated disclosure of environmental sanctions required by the US Securities and Exchange Commission (SEC) if they: a) operate in environmentally sensitive industries, b) are subject to relatively larger penalties, and c) voluntarily participate in a supplemental environmental project. Matsumura, Prakash and Vera-Muñoz (2014) studied CDP disclosures by S&P 500 firms and examined the effects of the disclosures on firm value. The study found that increased carbon emissions result in decreased firm value as markets penalize all firms for their carbon emissions and their disclosure.

The relationship between environmental disclosures and public policy pressure was studied by Walden and Schwartz (1997), who investigated changes in the levels of environmental disclosures following the 1989 Alaskan Exxon Valdez oil spill in four industries, including the oil industry. A significant positive difference in the levels of environmental disclosures was found from the years 1988 to 1989 and from 1989 to 1990. These findings indicate that environmental disclosures are time or event-specific. They are made in response to public policy pressure and designed according to the firms' self-interest. Cho (2009) studied legitimation strategies adopted by Total SA in response to the environmental disaster it faced. The study found that the company used communication strategies to legitimate its actions and support its argument. These examples reveal that environmental and social disclosures are used as a legitimacy device rather than an effort to demonstrate greater accountability. Discretionary environmental disclosure by polluting industries in the US was studied Clarkson, Li, Richardson and Vasvari (2008) by developing a content analysis index based on GRI guidelines. The analysis found that voluntary environmental disclosure is positively associated with environmental performance.

Brouhle and Harrington (2009) studied firms' strategic behaviour and the Canadian Voluntary Carbon Reporting (VCR) program. They found that participation rates, quality of action plans, and repeat participation rates significantly improved throughout the course of the VCR program via an increased perception of regulatory threat with ratification of the Kyoto Protocol. The study found a significant difference in the degree of involvement across provinces due to differences in the regulatory stringency for climate change mitigation. Chelli et al. (2018) examined changes in reporting practices by firms in Canada and France in reaction to environmental laws and regulations. The study examined the change in firms' disclosure in response to regulations in France and Canada through the lens of institutional legitimacy. The finding was that the French parliamentary regime was more successful than the Canadian stock exchange regulation in triggering environmental reporting. The study found that voluntary disclosures consistent with GRI Guidelines and GRI combined with local regimes prompted environmental disclosures.

Meng, Zeng and Tam (2013) found that ownership structure and mandatory reporting regulations influence environmental information disclosure in a Chinese context. Yu and Rowe (2017) found that regulations and government influence are the main enablers for corporate social and environmental reporting firms in China. Huang, Ren, Chen and Ning (2018) studied CDP disclosure by Chinese companies from 2008 to 2012 and found that environmental legitimacy significantly negatively influences carbon disclosure. Liu and Anbumozhi (2009) found that pressure from the government influences environmental information disclosure by Chinese companies.

Studies in an Australian context focused on that country's National Greenhouse and Energy Reporting (NGER) Scheme introduced in 2007, which established a single national framework for reporting and disseminating company information about GHG emissions, energy production, and energy consumption. Corporate responses under the NGER scheme were

studied by Lodhia and Martin (2012) and Liu, Abhayawansa, Jubb and Perera (2017). Lodhia and Martin (2012) found that the primary focus of corporates towards the pre-NGER legislation policy paper was on core reporting issues and challenges in the implementation of the Act, and concerns by other stakeholders focused on wider issues, such as carbon pollution and climate change. Liu, Abhayawansa, Jubb and Perera (2017) noted that the implementation of NGER had a positive effect on voluntary climate change-related disclosures in the public sector. Mandating GHG emission disclosure influences the voluntary disclosure of a broad range of related information, particularly in organisations not subject to capital markets incentives.

While analysing environmental disclosure and corporate environmental policies, Tilt (2001) found that environmental reporting trends among Australian companies were behind those of companies in other countries. The study found disagreements between the contents of environmental policies of Australian firms and their environmental disclosure. Even though companies were undertaking environmental reporting internally, a low priority was given to providing environmental performance data to external parties. A study of corporate environmental reporting practices across voluntary and mandatory disclosure systems by Cowan and Gadenne (2005) found higher levels of positive environmental information in the voluntary sections than in the statutory sections of the annual reports of Australian listed companies. Using a scoring system based on the reporting framework of the Climate Disclosure Standards Board (CDSB), Cotter, Najah and Wang (2011) found an inadequate amount of disclosure among Australian firms. Companies reported on some aspects of climate change impacts and the management of those aspects, but the disclosures were skewed towards the more positive aspects and lacked technical detail. A study of voluntary corporate GHG emissions reporting in Australia by Rankin, Windsor, and Wahyuni (2011) found that internal organisation systems factors, such as environmental management systems (EMS), corporate governance quality, environmental management committees, and external private guidance provided by the GRI and the CDP, influence GHG disclosures.

In a study of how climate change disclosure by Australian mining companies was made to ensure their social license to operate, Pellegrino and Lodhia (2012) found that the issue of climate change was creating a legitimacy threat for the whole mining industry. While analysing various methods used by Australian firms to assess scope 3 emissions, Downie and Stubbs (2013) found a wide discrepancy in the number of emission sources reported. The study suggests the need for more comprehensive guidance on emission sources to improve the relevance and completeness of disclosure on inventory sources in accordance with the GHG Protocol[4].

Luo and Tang (2014) studied the reliability of carbon information disclosure and examined whether voluntary carbon disclosure reflects firms' true carbon performance. Content analysis of CDP reports of companies from the US, UK, and Australia using a carbon performance index found a significant positive association between carbon disclosure and performance, which indicates that voluntary carbon disclosure to the CDP is indicative of carbon performance, supporting signalling theory. In the study of the disclosure gap between what information stakeholders expect and what Australian firms disclose, Haque, et al. (2016) found a low level of disclosures made by Australian firms due to lack of proactive stakeholder engagement and a concern about financial performance.

Perera, Jubb and Gopalan (2019) studied voluntary and mandated climate change-related disclosure by companies in Australia that are subject to specific environmental legislation - the

[4] The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) in partnership created GHG Protocol and the organization works with governments, industry associations, NGOs, businesses and other organizations.

NGER Act (2007). The study found that legislation-affected companies increased their disclosures compared with non-affected companies. The study found an increase in the level of emissions disclosures in legislation-affected companies after NGER implementation. Legislation-affected higher emitters have higher levels of voluntary disclosures. The findings support the legitimacy theory, which predicts differential disclosures in the circumstances to avoid scrutiny.

Cormier, Magnan, and Van Velthoven (2005) studied environmental disclosure quality and its determinants using institutional theory, public pressure, and economic incentives. The study found that disclosure among large German companies was converging over time, supporting the institutional theory. A study of CDP reports from 2003 to 2010 by Matisoff, Noonan and O'Brien (2013) analysed the extent to which firms account for indirect emissions. The study noted an increase in transparency in CDP reporting of scope 2 emission over the years; however, transparency and the quality of scope 3 emission reporting had not improved over the years. Country/region-wise, the study found that Japanese and European companies are more transparent, and US companies are less transparent. Energy-intensive industries have increased transparency compared to less energy-intensive industries.

In a study of carbon reduction practices and strategies by carbon-intensive firms from EU countries, Cadez and Czerny (2016) found that firms focus on a single climate change mitigation strategy rather than deploying several simultaneously, and policy stringency appears to have a positive effect on corporate efforts to reduce emissions. Comyns (2016) studied how institutional pressure influences GHG emission disclosure by global oil and gas companies and found that the EU emissions trading system (ETS) regulation and GRI Guidelines lead to more extensive and better-quality reporting.

Sakhel (2017) studied corporate climate risk perceptions of companies using CDP disclosure for 126 European companies. Firms felt less exposed to physical and market risks than to regulatory risks. An analysis of the risk perception by companies in regulated and non-regulated industries by climate policy found more regulatory response measures by firms in regulated industries than firms part of non-regulated industries, which reveals the significant role of regulation in inciting corporate action. Schiemann and Sakhel (2019) studied how European companies report physical risks associated with climate change to CDP and found that firms under the EU ETS regulation have lower information asymmetry. Climate change-related regulation moderates the direction of the relationship between reported information and information asymmetry.

Tauringana and Chithambo (2015) studied the effect of guidance issued by the Department for Environment, Food & Rural Affairs (DEFRA) on GHG disclosure in 2009. The study used an index methodology to measure emission disclosure by considering several GHG reporting frameworks. The publication of the DEFRA guidance significantly improved GHG emission disclosure, and board size, director ownership, and ownership concentration also had a significant influence on GHG emission disclosure. The study found that ownership concentration, board size, and director ownership affect the extent of GHG information disclosure. The study suggested that voluntary guidance can increase disclosure in the same way as mandatory requirements. In the case of DEFRA, companies increased their disclosures in anticipation of the publication of the guidance.

Luo and Tang (2014) found a significant positive association between carbon disclosure and performance by content analysis of CDP reports of companies from the US, UK, and Australia using a carbon performance index. This finding indicates that voluntary carbon disclosure to the CDP indicates firms' underlying actual carbon performance, supporting signalling theory.

In a study of the relationships between GHG emissions and business performance measures for listed firms in the UK, Broadstock, Collins, Hunt and Vergos (2018) found that the decision to report emissions is not directly influenced by wider social/governance disclosure attitudes held by a firm. This outcome suggests that environmental responsibility and social responsibility are not associated with each other. Tang and Demeritt (2018) found that GHG emission disclosure by UK-listed companies depends on regulatory status and energy intensity, and the reporting varies by sector. Kouloukoui, Marinho, Gomes, de Jong, Kiperstok and Torres (2019) found increasing the number of independent directors on the board of directors to be one of the most effective strategies of mitigation and adaptation that can inhibit or pressure companies to become involved in climate management.

D'Amico, Coluccia, Fontana and Solimene (2016) found a low level of disclosure of environmental information by Italian listed companies. The study observes that the introduction of voluntary legislation only affected the content of quantitative environmental disclosures and was unsuitable for a highly industrialized developed country. Jaggi, Allini, Macchioni, and Zampella (2018) studied the usefulness of carbon information voluntarily disclosed by Italian firms and found a positive association between stock price and carbon disclosures. This result reveals that investors find carbon information useful for their investment decisions. Firms made higher disclosures if they were from highly polluting industries and had environmental committees. Using weighted and unweighted carbon disclosure indexes based on the Kyoto Protocol requirements, Jaggi et al. (2017) studied how managerial carbon disclosure decisions by Italian firms in polluting industries were influenced by environmental committees, institutional shareholdings, and board independence.

Saka and Oshika (2014) found a negative relation between corporate carbon emissions and the market value of equity in the context of Japanese companies. However, the carbon management disclosure had a positive relationship with the market value of equity and was stronger if the carbon emissions volume was larger.

Elijido-Ten, Kloot and Clarkson (2010) studied stakeholder expectations of the types of disclosures in a Malaysian context and found that the perceived significance of an environmental event had a significant impact on environmental disclosure decisions. The study found that firms used disclosure to "defend" the reasons behind the environmental event and explain the actions taken to rectify the situation. Ahmad and Haraf (2013) studied the nature and quality of environmental disclosure by Malaysian property development companies using the Clarkson et al. (2008) disclosure index. They found that these companies did not respond to increased public concern by increasing the extent or quality of environmental disclosures in their annual reports. Studies found companies provided mostly "soft" disclosures and very few "hard" disclosures and the study suggested mandatory regulation was required for better environmental reporting.

The CDP acts as an important global platform promoting voluntary disclosure on carbon disclosure. Grauel and Gotthardt (2016) found that national context influences firms' response rates to the CDP climate change program, which differ strongly between different countries globally, with multinational companies affected by the characteristics of their countries-of-origin. Matisoff (2013) studied the effectiveness of two types of information disclosure programs; a) CDP, which is a voluntary reporting system, and b) state-based mandatory carbon reporting programs. The study measured the impact of each program on carbon emissions, carbon intensity, and output and found neither program generated an impact on carbon emissions, emissions intensity, or output.

De Villiers and Van Staden (2011) found that levels of environmental disclosure in annual reports and on websites are contingent. When firms face an environmental crisis, they disclose

environmental information on their websites. When they have a poor environmental reputation, firms choose annual reports as the reporting channel.

Delmas, Nairn-Birch and Lim (2015) studied the dynamics of GHG emission and financial performance and found that corporate environmental performance improved from 2004 to 2008 and thereby a decline in short-term financial performance occurred. However, investors see the potential long-term value of improved environmental performance. Comyns and Figge (2015) studied the evolution of GHG reporting quality by oil and gas companies and whether the evolution of reporting quality was linked with the type of information disclosed. They found that GHG reporting quality had not improved significantly between 1998 and 2010. Alberici and Querci (2016) studied the quality of voluntary disclosure of environmental policy by financial intermediaries. The study noted that the quality of disclosures was associated with the financial intermediaries' attributes and the home country's characteristics. Cadez and Czerny (2016) noticed that carbon-intensive firms follow climate change mitigation strategies that minimize their economic exposure rather than drastically cutting carbon dioxide emissions.

Ott, Schiemann and Günther (2017) noted that different variables determine firms' response decisions and publication decisions. The response decision is related to disclosure preparation costs (the available financial resources, the existence of a certified environmental management system, and the publication of a corporate social responsibility report), and the publication decision is associated with proprietary costs (the environmental performance and the nature of the competitive environment). Ben-Amar, Chang and McIlkenny (2017) found that voluntary climate change disclosure increases with the number of female directors on boards. The study supported critical mass theory as female directors help in addressing stakeholders' demands for disclosure of the risks associated with climate change. Arena and Michelon (2018) studied disclosure practices in a firm's life cycle stages and found that middle-aged family firms, where the family identity dimension prevails, provided more environmental disclosure than non-family firms. Firms will implement carbon abatement projects as long as the marginal benefit of doing so exceeds the marginal cost (Blanco, Caro and Corbett, 2020).

The role of environmental disclosures in creating a legitimating effect on investors was studied by Milne and Patten (2002), who found that positive disclosures can restore or repair an organization's legitimacy under some circumstances. Talbot and Boiral (2015) studied impression management strategies that companies use to rationalize their impacts on climate change disclosures. This study identifies neutralization techniques that industrial emitters use to rationalize their impacts. Arena et al. (2015) found that the bias towards positive language in environmental reporting serves as a transparency tool to signal future environmental performance rather than as an opportunistic manipulation tool by the management.

The relationship between environmental performance, legislation, and annual report disclosure was studied by Buhr (1998). That study examined how firms respond to changing government regulations for sulphur dioxide abatement and how firms chose to present these abatement activities in their annual reports using legitimacy theory and political economy theory. Institutional investors use private climate change reporting (mostly about risk and risk management) to compensate for the inadequacies of climate change reporting done publicly (Solomon, Solomon, Norton and Joseph, 2011). Lister (2018) studied corporate carbon management practices, such as target setting, carbon pricing, and carbon reporting, and found that voluntary corporate climate governance efforts are essential and improving. However, the efforts are insufficient for meaningful decarbonization. Wegener, Labelle and Jerman (2019) studied the ability of carbon accounting to communicate comparable carbon performance information and found a lack of comparability and commensurability in GHG emission disclosure.

Based on the above discussions, the following hypotheses are investigated:

*H1a: Companies in countries that have Mandated environmental legislation will have a lower level of greenhouse gas emissions.*

*H1b: Companies in countries that have Voluntary environmental legislation will have a lower level of Greenhouse gas emissions.*

*H2a: There is a positive relationship between companies in countries that have Mandated environmental legislation and environmental disclosure.*

*H2b: There is a positive relationship between companies in countries that have Voluntary environmental legislation and environmental disclosure.*

## 3. Research method

This study examines the relationship between environmental legislation, carbon emissions and emissions disclosure. We examine 57 listed companies within the CDP top 100 global polluters and matching companies contingent on opposing mandatory or voluntary environmental legislation to investigate the relationship between mandated and voluntary environmental GHG legislation. We also investigate the relationship between mandated and voluntary environmental legislation on disclosures (through the use of the Bloomberg CDP environmental disclosure score). The sample consists of a multinational dataset consisting of companies from 2006 to 2015.

We use ordinary least squares (OLS) and control for multi level of fixed effects (Correia, 2017) to investigate the association between country-specific environmental legislation and greenhouse gas emissions, which addresses H1a and H1b. Similarly, multivariate tests are used to ascertain the relationship between country-specific environmental legislation and disclosures, addressing H2a and H2b. We control for variables found in prior research to have relationships with our variables of interest, such as company size and corporate governance characteristics. As mentioned, we also control for fixed effects such as year and region.

A number of sensitivity analysis tests are also conducted to ascertain the robustness of the results.

### *3.1 Sample selection*

The source of the data is based on the Carbon Majors Report 2017, which listed the top 100 polluting companies in the world from 2006 to 2015 with the yearly pollution information provided for each company by the Carbon Disclosure Project (CDP). This list consisted of both listed and non-listed companies.

Additional data were collected using WRDS Compustat, BoardEx and Bloomberg Databases for matching companies in the CDP dataset. Out of the 100 companies, some companies were not listed companies as noted above and therefore, the data was not available. Missing data or companies that were listed was hand collected from corporate annual reports for the relevant year.

The final list included 57 companies, which were observed together with the country and the nature of any environmental legislation within that country. The final dataset consists of 505 firm-year observations. Information relating to female directors and country-specific

legislation was hand-collected. An overview of the included countries by country and year is provided in Table 1.

**Table 1**
Sample overview – CDP Top 57 listed polluting companies (Based on CDP Top Polluters Report)

| | | Year | | | | | | | | | | Total Country Observations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **Region** | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | |
| Argentina | South America | | | | | | | 1 | 1 | 1 | 1 | 4 |
| Australia | Oceana | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Austria | EU | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Brazil | South America | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Canada | Americas | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 48 |
| China | Asia | | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 24 |
| Colombia | South America | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 |
| Denmark | EU | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| France | EU | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Germany | EU | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| India | South East Asia | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 15 |
| Indonesia | Asia | | | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 18 |
| Italy | EU | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Japan | Asia | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Netherlands | EU | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Norway | EU | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Russia | East EU | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 40 |
| South Africa | Africa | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 29 |
| Spain | South America | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Switzerland | EU | | | | | | 1 | 1 | 1 | 1 | 1 | 5 |
| Thailand | Asia | | | | | | 1 | 1 | 1 | 1 | 1 | 5 |
| UK | EU | | | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 14 |
| USA | Americas | 12 | 19 | 18 | 18 | 19 | 20 | 20 | 20 | 20 | 20 | 186 |
| **Total Sample** | | **32** | **45** | **47** | **47** | **51** | **55** | **57** | **57** | **57** | **57** | **505** |
| **Sample with Bloomberg Environmental Disclosure Score** | | **16** | **22** | **23** | **26** | **28** | **32** | **34** | **8** | **9** | **31** | **229** |

A detailed overview of the specific legislation by country and its mandated or voluntary nature is provided in Table 2. In is interesting to note that only 10 countries from the 23 in the sample had some from of environmental legislation in place during the observation period.

### *3.2 Bloomberg CDP Corporate Disclosure Index*

The index is constructed from the CDP data available in Bloomberg by choosing items based on relevance. Companies that answered the CDP questionnaire in each year of study are identified, and the disclosure level is measured using the Carbon Disclosure Index (CDI).

A Carbon Disclosure Index (CDI) with 56 items based on the CDP questionnaire as shown in Table 3 is constructed. The CDI is a comprehensive list comprising of 56 reporting items under seven broad categories, such as Reporting Period, Risks and Opportunities, GHG Emissions, Energy Use, Trading, Targets and Initiatives, Governance and Strategy. The disclosure score obtained for each company is calculated by the number of disclosed items.

**Table 2**
Country specific legislation overview –

| **Country** | Regulation | Type (Mandated/Voluntary) | Year introduced | Year in effect |
|---|---|---|---|---|
| Australia | National Greenhouse and Energy Reporting Regulations | M | 2007 | 2008 |
| Canada | Canadian Environmental Protection Act (The National Pollutant Release Inventory (NPRI)) | M | 1999 | 2000 |
| Canada | GHG Emission Reporting Scheme | M | 2004 | 2005 |
| China | National Development and Reform Commission (NDRC) GHG accounting and reporting guidelines | M | 2014 | 2016 |
| Colombia | National Program for Voluntary Report on GHG Emissions. | V | 2012 | 2013 |
| France | France: Bilan Carbone | V | 2004 | 2005 |
| France | Granelle 2 | M | 2012 | 2013 |
| Japan | Mandatory GHG Accounting and Reporting System | M | 2005 | 2006 |
| South Africa | Air Quality Act | V | 2004 | 2005 |
| South Africa | National Greenhouse Gas Emissions Reporting Regulations | M | 2017 | 2018 |
| South Korea | Greenhouse Gas and Energy Target Management System | V | 2010 | 2011 |
| Spain | GHG Emissions Registry | V | 2014 | 2015 |
| UK | DEFRA Environmental Reporting Guidelines: Including mandatory greenhouse gas emissions reporting guidance, | M | 2013 | 2014 |
| UK | Climate Change Act (GHG reporting) | V | 2008 | 2009 |
| UK | Guidance on how to measure your GHG emissions | V | 2009 | 2010 |
| USA | SEC Guidance on Disclosure Related to Climate Change | V | 2010 | 2011 |
| USA | EPA 40 CFR Parts 86, 87, 89 et al. Mandatory Reporting of GHG emissions, | M | 2009 | 2010 |

**Table 3**
Bloomberg Carbon Disclosure Index

| **Category** | **Subcategories** | **No. of variables** | **Score** | |
|---|---|---|---|---|
| A | Reporting Period | 4 | 4 | |
| B | Risks and Opportunities | 6 | 6 | Final |
| C | GHG Emissions | 23 | 23 | Score |
| D | Energy Use | 10 | 10 | (%) |
| E | Trading | 4 | 4 | |
| F | Targets and Initiatives | 2 | 2 | |
| G | Governance and Strategy | 7 | 7 | |
| **Carbon Disclosure Score** | | **56** | **56** | |

### *3.3 Greenhouse Gas Emissions — hypothesis variable*

The variable of interest is the Emissions (EMS). The mandated EMS is measured as the natural log of GHG emissions measured in megatonnes. This data was gathered from the CDP database for the period of 2006 to 2015 inclusive. This variable is the total of Scope 1 and Scope 3 emissions for each organisation. 3.3 Greenhouse Gas Emissions — hypothesis variable

The CDP is an organisation based in the United Kingdom that supports companies and cities to disclose their environmental impact. It promotes carbon disclosure by publishing the reports based on the questionnaire sent to companies around the globe. The Bloomberg Professional database features CDP climate change disclosure data by companies from various countries. Out of all items available in the Bloomberg database, the 56 items under seven major sub-categories, such as Reporting Period, Risks and Opportunities, GHG Emissions, Energy Use, Trading, Targets and Initiatives, Governance and Strategy, were chosen to construct the Carbon Disclosure Index (CDI). Each item of the index is given the same weightage, and the total disclosure score obtained by each company is calculated by the number of total disclosed items, with a score of 1 for disclosed items and a score of 0 for non-disclosed items.

### *3.4 Other factors potentially affecting the relationship*

Prior literature has identified a number of other factors that may affect emissions or disclosures. Company size is a factor that potentially affects emissions and also voluntary environmental disclosures (Perera et al., 2019). Larger emitters are also likely to be larger companies. Larger firms are observed to disclose more extensively (Chithambo and Tauringana, 2014; Luo et al., 2012). SIZE is measured as the natural log of total assets as disclosed in the company's financial reports.

There are mixed results for corporate governance variables and our variables of interest in prior literature. Board size and the number of independent directors are found to be associated with CSR performance (Harjoto et al., 2015; Isidro and Sobral, 2015; Sundarasen et al., 2016). Additionally, commercial ratings (such as KLD or Bloomberg) (Deschênes et al., 2015; Giannarakis et al., 2014), including GHG data, also have an association with corporate governance variables.

In terms of the number of independent directors, Braam et al. (2016) and Chithambo and Tauringana (2017) do not find a significant relationship with CSR disclosures. We include independent directors (INDDIR) as it may be positively associated with GHG emissions, as it can be argued that independent directors drive organisations to be better CSR performers. Similarly, we also control for female directors following Perea et. al (2019).

Year control variables and region control variables are included to control for macroeconomic effects, including the Global Financial Crisis (GFC), which occurred during 2007 and 2008. Additionally, the European financial crisis was controlled in 2011 and 2012. It is also important to control for the year since the same organisations can appear annually over the 10 years, and also there are broader macroeconomic factors that could affect the hypothesis variables.

While some studies, such as (Perera et. al, 2019), have controlled for environmentally sensitive sectors, given that the sample only consisted of environmentally sensitive sectors, we have not included a variable for the same.

### *3.5 The models*

OLS regression models are used in the analysis[5]. All regressions are robust, adjusting for White's (1980) heteroscedasticity issues associated with panel data by clustering on company identity[6]. We also control for fixed effects such as region and year-related effects using Stata (see Correia, 2017).

The model for testing H1a and H1b investigates the association between mandated and voluntary environmental legislation and emissions using the following equation:

$$EMS_{it} = \propto_i + \beta_1 MLEG_{it} + \beta_2 VLEG_{it} + \beta_3 SIZE_{it} + \beta_{4-6}\, CORPGOV_{it} \rightarrow Equation\ 1$$

Controlling for year and region fixed effects, where, for company *i* at time *t*:

| | | |
|---|---|---|
| EMS | = | Natural log of total emissions reported |
| MLEG | = | Dichotomous variable where 1 indicates country-specific mandated environmental legislation; 0 otherwise |
| VLEG | = | Dichotomous variable where 1 indicates country-specific voluntary environmental legislation; 0 otherwise |
| SIZE | = | Organisation size measured as natural log of total assets |
| CORPGOV | = | Corporate governance variables consisting of square root of board size, square root of the number of independent directors and the square root of female directors. |

In relation to H2a and H2b, to ascertain the relationship between environmental legislation and corporate disclosure scores, the following OLS regression is used. As before, the same equation is used for this iteration, with the dependent variable changing from Emissions (EMS) to Corporate Disclosures (CDI):

$$CDI_{it} = \propto_i + \beta_1 MLEG_{it} + \beta_2 VLEG_{it} + \beta_3 SIZE_{it} + \beta_{4-6}\, CORPGOV_{it} + \varepsilon_{it} \rightarrow Equation\ 2$$

Controlling for year and region fixed effects, where for company *i* at time *t*:

| | | |
|---|---|---|
| CDI | = | Disclosure Rating score provided by the Bloomberg Database based on CDP; |

A separate series of robustness tests are conducted to examine the validity of the results using the following equations, controlling for countries included in the Kyoto agreement:

[5] Some sensitivity analyses were conducted using logistic regressions.
[6] We also carry out further sensitivity analysis using clustering by country.

$$EMS_{it} = \propto_i + \beta_1 MLEG_{it} + \beta_1 VLEG_{it} + \beta_2 KYOTO_{it} + \beta_3 SIZE_{it} + \beta_{4-6} CORPGOV_{it} + \varepsilon_{it}$$
$$\rightarrow Equation\ 3$$

Controlling for year and region fixed effects, where for company *i* at time *t* variables are as defined previously, and:

| | | |
|---|---|---|
| KYOTO | = | Dichotomous variable equal to 1 if the country is a signatory to the Kyoto agreement, 0 otherwise. |

The same sensitivity analysis is carried out for the Corporate disclosure dependent variable by replacing the Emissions variable (EMS) with the Corporate Disclosure variable (CDI). An additional sensitivity analysis is conducted for the entire sample, comparing the companies with a CDI score with companies that do not have a CDI score, using a logistic regression, as follows:

$$CDID_{it} = \propto_i + \beta_1 MLEG_{it} + \beta_2 VLEG_{it} + \beta_3 KYOTO_{it} + \beta_4 SIZE_{it} + \beta_{5-7} CORPGOV_{it} + \varepsilon_{it}$$
$$\rightarrow Equation\ 4$$

Controlling for year and region fixed effects, where for company *i* at time *t* variables are as defined previously, and:

| | | |
|---|---|---|
| CDID | = | Dichotomous variable equal to 1 if a CDI score is present, 0 otherwise. |

## 4. Results

### *4.1 Descriptive statistics*

Table 4, Panels A and B provide descriptive statistics for the analyses. In relation to the total sample (Panel A), the mean Emissions is 293.86 megatonnes, with a minimum of 15 megatonnes and maximum of 8674.39 megatonnes. Sample companies range in size (total assets) from $541M to $349,493M, with a mean of $45,174M. Board size ranges from 5 to 26 directors, with a mean of 12. Independent director numbers range between 1 and 12, with a mean of 2 directors. Female directors has a minimum of 0 and a maximum of 5 with a mean of 1 director.

Table 4, Panel B provide the descriptive stats for the Corporate Disclosure sample. For this sample, the mean Emissions is 199.25 megatonnes, with a minimum of 26.56 megatonnes and maximum of 1297.24 megatonnes. Companies range in size (total assets) from $899M to $336,758M, with a mean of $56,821M. Board size ranges from 6 to 26 directors, with a mean of 13. Independent director numbers range between 1 and 12, with a mean of 2 directors. The female directors has a minimum of 0 and a maximum of 5, with a mean of 1 director.

**Table 4**
Descriptive statistics[7]

| Variables | Total Sample Panel A (N=505) | | | | | Corporate Disclosure Sample Panel B (N=229) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | Mdn | Std. Dev. | Min | Max | Mean | Mdn | Std. Dev. |
| EMISSIONS (Mt) | 15.26 | 8674.39 | 293.86 | | 904.26 | 26.56 | 1297.24 | 199.25 | | 217.08 |
| CDI | | | | | 12.81 | 1.79 | 83.93 | 39.43 | | 12.81 |
| CDID | 0 | 1 | 0 | | | | | | | |
| MLEG | 0 | 1 | 0 | | | 0 | 1 | 0 | | |
| VLEG | 0 | 1 | 0 | | | 0 | 1 | 0 | | |
| KYOTO | 0 | 1 | 1 | | | 0 | 1 | 1 | | |
| SIZE (US$000) | 541 | 349493 | 45174 | | 58425 | 899 | 336758 | 56821 | | 65059 |
| BDSIZE (No) | 5.00 | 26.00 | 12.22 | | 3.35 | 6.00 | 26.00 | 12.97 | | 3.49 |
| INDDIR (No) | 1.00 | 12.00 | 1.76 | | 1.27 | 1.00 | 12.00 | 1.69 | | 1.29 |
| FEMDIR (No) | 0.00 | 5.00 | 1.36 | | 1.22 | 0.00 | 5.00 | 1.53 | | 1.15 |

EMISSIONS= Total emissions (Megatonnes); CDI=Corporate Environmental Disclosure score based on Bloomberg CDP Scoring for companies; DCID = Dichotomous variable where 1 indicates having a CDI Score, 0 otherwise; MLEG= Dummy where 1 indicates the existence of a country-specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country-specific voluntary environmental legislation, 0 otherwise; KYOTO= Dummy where 1 indicates country specific signatory to Kyoto agreement, 0 otherwise; SIZE=Company size; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board;

### *4.2 Non-parametric statistics*

Table 5 provides an overview of the results of independent t-tests for the Total GHG emissions by companies belonging in each of the grouping variables, namely:

1. Mandatory corporate GHG emission reporting regulatory regime and non-mandatory GHG emission reporting regulatory regime.
2. Voluntary corporate GHG emission reporting regulatory regime and non-voluntary GHG emission reporting regulatory regime.
3. Countries that are listed in Annex 1 of Kyoto Protocol and countries that are not listed in Annex 1 of Kyoto Protocol.

For mandated legislation compared with non-mandated legislation regimes, the results suggest that there is a significant difference in total GHG emissions between the two groups. Total GHG emissions are significantly different between the non-mandatory and mandatory regulatory reporting groups. Similarly, for the two groups with voluntary legislative and non-voluntary or non-legislative groups, independent t-tests suggest that there is a significant difference in Total GHG emissions between the two groups. For countries that follow the Kyoto agreement and those that do not, independent t-tests identify a statistically significant difference in Total GHG emissions.

**Table 5**
Independent sample t-tests

**Panel B: Independent sample t-test results**

[7] In relation to the companies which were affected by legislation, 246 companies were not covered by either mandated or voluntary environmental legislation. 86 companies were covered by mandated environmental legislation and 35 were covered by voluntary environmental legislation. 138 companies were covered by both mandated and voluntary environmental legislation.

| **Total GHG Emission** | | **Levene's Test for Equality of Variances** | | **t-test for Equality of Means** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **F** | **Sig.** | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** | **Std. Error Difference** |
| Mandatory Regulation | Equal variances assumed | 18.02 | 0.000 | 3.07 | 503.00 | 0.002 | 246.81 | 80.32 |
| | Equal variances not assumed | | | 3.43 | 291.53 | 0.001 | 246.81 | 71.96 |
| Voluntary Regulation | Equal variances assumed | 11.17 | 0.001 | 2.15 | 2.15 | 0.032 | 181.98 | 84.48 |
| | Equal variances not assumed | | | 2.15 | 355.26 | 0.003 | 181.98 | 61.77 |
| Kyoto Protocol | Equal variances assumed | 79.39 | 0.000 | 4.63 | 503.00 | 0.000 | 454.54 | 98.26 |
| | Equal variances not assumed | | | 2.38 | 101.74 | 0.019 | 454.54 | 190.86 |
| Carbon Disclosure | Equal variances assumed | 12.56 | 0.000 | 2.15 | 503.00 | 0.032 | 173.10 | 80.54 |
| | Equal variances not assumed | | | 2.35 | 296.47 | 0.020 | 173.10 | 73.78 |

Table 6 provides an overview of the descriptive stats for the t-test sample. In relation to the number of observations that have mandated regulations, there are 224 observations with mean greenhouse gas emissions of 156.52 megatonnes. The non-mandatory group has 281 observations in total (246 without any legislation and 35 with voluntary legislation) with a mean greenhouse gas emissions of 403.33 megatonnes. For the voluntary group, there are 173 observations with a mean greenhouse gas emissions of 174.21 megatonnes and the non-voluntary group has 332 observations (including mandated observations which was 86) with a mean of 356.20 megatonnes. The number of observations that fall under the Kyoto agreement is 403 company observations with a mean of 202.05 megatonnes of greenhouse gas emissions, and the group that is not a signatory to the Kyoto agreement has 102 observations with a mean of 656.59 megatonnes.

**Table 6**
Independent sample t-tests

**Group Statistics: Total GHG Emission**

| | | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Mandatory Regulation | Voluntary Reporting | 281 | 403.33 | 1194.16 | 71.23 |
| | Mandatory Reporting | 224 | 156.52 | 153.263 | 10.24 |
| Voluntary Regulation | Mandatory Reporting | 332 | 356.20 | 1105.13 | 60.65 |
| | Voluntary Reporting | 173 | 174.21 | 154.27 | 11.72 |
| Kyoto Protocol | Kyoto Non-Annexe 1 | 102 | 656.59 | 1924.09 | 190.51 |
| | Kyoto Annexe 1 | 403 | 202.05 | 230.61 | 11.48 |

Table 7, Panels A and B provide an overview of the Pearson and Spearman correlations for the

**Table 7**
Panel A - Pearson's & Spearman's Correlations for full sample (N=505) - H1a & H1b

| Variable | EMS | MLEG | VLEG | SIZE | BDSIZE | INDDIR | FEMDIR |
|---|---|---|---|---|---|---|---|
| EMS | | **-.208**** | **-0.061** | **.381**** | **-0.026** | **-.145**** | **.174**** |
| MLEG | -.205** | | **.515**** | **.141**** | **-.151**** | **.451**** | **0.087** |
| VLEG | -0.02 | .515** | | **-0.075** | **-.177**** | **.278**** | **.120**** |
| SIZE | .413** | .116** | -0.065 | | **.095*** | **0.035** | **.292**** |
| BDSIZE | 0.009 | -.107* | -.159** | 0.036 | | **-.132**** | **.399**** |
| INDDIR | -.171** | .515** | .345** | -0.023 | -.186** | | **-.122**** |
| FEMDIR | .225** | 0.073 | .092* | .275** | .393** | -.181** | |

Note: Pearson's correlations bolded and Spearman's correlation in non-bolded. ***=significant at 1%, **=significant at 5%, *=significant at 10%. All standard errors are robust. EMS= Natural log of total emissions (Megatonnes); MLEG= Dummy where 1 indicates the existence of a country specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country specific voluntary environmental legislation, 0 otherwise; SIZE=Natural log of total assets; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board;

total sample and the disclosure index scored (CDI) sample, respectively. In Table 8, Panel A, there is a correlation that is negative and significant between the volume of emissions and mandated regulations. Similarly, there is a positive correlation between volume of emissions and both company size and the number of female directors. For the corporate disclosure sample, which is presented in Table 8, Panel B, there is a positive and significant correlation between the disclosure index and mandated legislation. The correlations between the CDI and company size, board size, and female directors are all positive and significant.

**Table 7**
Panel B - Pearson's & Spearman's Correlations for companies with disclosure scores (N=229) – H2a & H2b

| Variable | CDI | MLEG | VLEG | SIZE | BDSIZE | INDDIR | FEMDIR |
|---|---|---|---|---|---|---|---|
| CDI | | **.135*** | **-0.023** | **.230**** | **.241**** | **-0.042** | **.391**** |
| MLEG | .167* | | **.226**** | **.221**** | **-0.083** | **.451**** | **0.087** |
| VLEG | 0.079 | .226** | | **-.161*** | **-.132*** | **0.116** | **.120**** |
| SIZE | .236** | .136* | -0.095 | | **0.005** | **.133*** | **.292**** |
| BDSIZE | .315** | 0 | -0.095 | -0.011 | | **-0.108** | **.399**** |
| INDDIR | -0.067 | .490** | .162* | 0.084 | -.132* | | **-.122**** |
| FEMDIR | .414** | 0.073 | .092* | .275** | .393** | -.181** | |

Note: Pearson's correlations bolded and Spearman's correlation in non-bolded. ***=significant at 1%, **=significant at 5%, *=significant at 10%. All standard errors are robust. CDI=Corporate Environmental Disclosure score based on Bloomberg CDP Scoring for companies; MLEG= Dummy where 1 indicates the existence of a country specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country specific voluntary environmental legislation, 0 otherwise; KYOTO= Dummy where 1 indicates country specific signatory to Kyoto agreement, 0 otherwise; SIZE= Natural log of total assets; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board;

### *4.3 Regression results*

Table 8 reports results for the tests of H1a and H1b. For H1a, we investigate the association between mandated legislation and emissions. The robust regression controlling for fixed effects has an F value of 7.33 ($p < 0.001$) and an Adj. $R^2$ of 38 per cent.

The result for H1a is negative and significant. That is, companies affected by the mandated environmental legislation have a lower level of emissions compared to companies that do not have mandated environmental legislation. Company size is positive and significant as expected.

With regards to H1b, results are positive and significant, suggesting that countries with voluntary environmental legislation regimes have higher emissions. This is contrary to what was expected. The results suggest that voluntary environmental legislation does not contribute to organisations' emission reductions.

Additionally, board size is negative and significant, suggesting that larger boards have a negative association with emissions, which suggests that larger boards lead to lower emissions. Furthermore, female directors are positive and significant, suggesting that a higher number of females on the board is associated with higher emissions, which is an unexpected finding.

**Table 8**
Regressions for Greenhouse gas emissions and legislation (mandated and voluntary)[8][9]

| **Variables** | Dependent Variable = EMS<br>Mandatory and Voluntary Environmental Legislation as explanatory variable (N=505; 57 Clusters; Controlling for 7 region and 10 year fixed effects) - H1a and H1b | | |
|---|---|---|---|
| | **Coeff.** | **Std. Err.** | **t** |
| MLEG | -0.48 | 0.22 | -2.15** |
| VLEG | 0.55 | 0.18 | 3.08*** |
| SIZE | 0.31 | 0.08 | 3.89*** |
| BDSIZE | -0.54 | 0.19 | -2.78*** |
| INDDIR | -0.05 | 0.22 | -0.21 |
| FEMDIR | 0.34 | 0.12 | 2.88*** |
| _constant | 3.50 | 0.78 | 4.52*** |
| F-Statistic | | 7.33 | |
| Prob | | 0.001 | |
| Adj. $R^2$ | | 0.38 | |

***=significant at 1%, **=significant at 5%, *=significant at 10%. All standard errors are robust. EMS= Total emissions (Megatonnes); MLEG= Dummy where 1 indicates the existence of a country-specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country-specific voluntary environmental legislation, 0 otherwise; SIZE=Natural log of total assets; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board, controlling for region and year fixed effects.

Sensitivity analysis for H1 is provided in Table 9. The results remain significant, with no significant change to the original results. We also did additional tests using Scope 1 and Scope 3 emissions independently as the dependent variable. The results remain significant as per the original analysis without any change. Therefore, H1a and H1b are further supported by the sensitivity analysis. Interestingly, the Kyoto protocol control is not significant. [10]

**Table 9**
Sensitivity Analysis for Greenhouse Gas Emissions and Environmental Legislation, controlling for Kyoto agreement

| **Variables** | Dependent Variable = EMS |
|---|---|

[8] No change in result when clustering by country.
[9] The results remain significant when using Scope 1 and Scope 3 emissions separately.
[10] We also analysed the results when splitting the sample at its midpoint based on Year, and the results remain consistent to the original findings.

| | Mandatory and Voluntary Environmental Legislation as explanatory variable (N=505; 57 Clusters; Controlling for region and year fixed effects) - H1a and H1b | | |
|---|---|---|---|
| | **Coeff.** | **Std. Err.** | **t** |
| MLEG | -0.48 | 0.21 | -2.31** |
| VLEG | 0.55 | 0.18 | 3.07*** |
| SIZE | 0.31 | 0.08 | 3.87*** |
| BDSIZE | -0.54 | 0.19 | -2.85*** |
| INDDIR | -0.05 | 0.22 | -0.21 |
| FEMDIR | 0.34 | 0.12 | 2.86*** |
| KYOTO | 0.01 | 0.49 | 0.03 |
| _constant | 3.50 | 0.84 | 4.15*** |
| F-Statistic | | 6.67 | |
| Prob | | 0.001 | |
| Adj. $R^2$ | | 0.39 | |

***=significant at 1%, **=significant at 5%, *=significant at 10%. All standard errors are robust. EMS= Total emissions (Megatonnes); MLEG= Dummy where 1 indicates the existence of a country-specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country-specific voluntary environmental legislation, 0 otherwise; SIZE=Natural log of total assets; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board, controlling for region and year fixed effects.

Table 10 explores the association between mandated (H2a) and voluntary (H2b) regulation with CDI scores. The sample size is reduced to 229 company–years. The robust regression has an F value of 2.28 ($p < 0.058$) and an Adj. $R^2$ of 64 per cent. The results suggest that there is a negative and significant relationship between voluntary environmental legislation and disclosure scores, suggesting that voluntary environmental disclosures are negatively associated with corporate dis closures in the presence of such legislation. We find the opposite of H2b to be supported. This does not apply to mandatory environmental disclosures, where the results are not significant. Therefore, H2a is not supported. This is surprising as it was expected that mandated environmental legislation would have a positive and significant relationship with disclosure scores.

**Table 10**
Regressions for Corporate disclosures and legislation (mandated and voluntary)[11]

| **Variables** | Dependent Variable = CDI<br>Mandatory and Voluntary Environmental Legislation as explanatory variable (N=229; 35 Clusters; Controlling for 8 region and 10 year fixed effects) – H2a and H2b | | |
|---|---|---|---|
| | **Coeff.** | **Std. Err.** | **t** |
| MLEG | 3.06 | 2.88 | 1.06 |
| VLEG | -5.05 | 2.60 | -1.94** |
| SIZE | 1.17 | 1.00 | 1.17 |
| BDSIZE | 2.94 | 2.61 | 1.13 |
| INDDIR | 1.44 | 2.04 | 0.71 |
| FEMDIR | 2.61 | 1.59 | 1.64 |
| _constant | 12.52 | 13.53 | 0.93 |
| F-Statistic | | 2.28 | |
| Prob | | 0.058 | |
| Adj. $R^2$ | | 0.64 | |

[11] No change in result when clustering by country.

***=significant at 1%, **=significant at 5%, *=significant at 10%. All standard errors are robust. CDI= Bloomburg Disclosure Score; MLEG= Dummy where 1 indicates the existence of a country-specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country-specific voluntary environmental legislation, 0 otherwise; SIZE=Natural log of total assets; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board, controlling for region and year fixed effects.

Sensitivity analysis for H2 is provided in Table 11. The results supports the original findings as per Table 9. Interestingly, the control variable for Kyoto protocol is not significant.

**Table 11**
Sensitivity Analysis for Corporate Disclosures and Environmental Legislation, controlling for Kyoto agreement

| **Variables** | Dependent Variable = CDI<br>Mandatory and Voluntary Environmental Legislation as explanatory variable (N=229; 35 Clusters; Controlling for region and year fixed effects) – H2a and H2b | | |
|---|---|---|---|
| | **Coeff.** | **Std. Err.** | **t** |
| MLEG | 1.93 | 2.61 | 0.74 |
| VLEG | -4.78 | 2.53 | -1.89* |
| SIZE | 1.30 | 0.91 | 1.43 |
| BDSIZE | 2.70 | 2.52 | 1.07 |
| INDDIR | 0.87 | 2.07 | 0.42 |
| FEMDIR | 2.49 | 1.54 | 1.61 |
| KYOTO | 7.06 | 4.89 | 1.44 |
| _constant | 7.26 | 13.26 | 0.55 |
| F-Statistic | | 2.45 | |
| Prob | | 0.037 | |
| Adj. $R^2$ | | 0.65 | |

***=significant at 1%, **=significant at 5%, *=significant at 10%. All standard errors are robust. CDI=Bloomberg Disclosure Score; MLEG= Dummy where 1 indicates the existence of a country-specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country-specific voluntary environmental legislation, 0 otherwise; SIZE=Natural log of total assets; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board, controlling for region and year fixed effects.

**Table 12**
Additional analysis for Corporate disclosures, non-disclosures and legislation (mandated and voluntary), controlling for Kyoto agreement

| **Variables** | Dependent Variable = CDID<br>Mandatory and Voluntary Environmental Legislation as explanatory variable (N=505; 57 Clusters; Controlling for region and year fixed effects) – H2a and H2b | | |
|---|---|---|---|
| | **Coeff.** | **Std. Err.** | **t** |
| MLEG | 0.23 | 0.09 | 2.55** |
| VLEG | -0.26 | 0.10 | -2.67** |
| SIZE | 0.11 | 0.02 | 5.28*** |
| BDSIZE | 0.20 | 0.09 | 2.25** |
| INDDIR | -0.07 | 0.09 | -0.82 |
| FEMDIR | -0.17 | 0.07 | -2.29** |
| KYOTO | 0.17 | 0.08 | 2.16** |
| _constant | -1.17 | 0.35 | -3.33*** |
| F-Statistic | | 14.14 | |
| Prob | | 0.001 | |
| Adj. $R^2$ | | 0.33 | |

***=significant at 1%, **=significant at 5%, *=significant at 10%. All standard errors are robust. CDID= Dichotomous variable where 1 if disclosure score available on Bloomburg, 0 otherwise; MLEG= Dummy where 1 indicates the existence of a country-specific mandated environmental legislation, 0 otherwise; VLEG= Dummy where 1 indicates the existence of a country-specific voluntary environmental legislation, 0 otherwise; SIZE=Natural log of total assets; BDSIZE=Number of members on the board; INDDIR=Number of independent directors on the board; FEMDIR= Number of female directors on the board, controlling for region and year fixed effects.

Additional analysis is conducted between the groups that have a disclosure score and those that do not have a score, with the sample size of 505 observations. These results are provided in Table 12. The fixed effects regression has an F value of 14.14 ($p < 0.001$) and an Adj. $R^2$ of 33 per cent. In this instance, results suggest that there is a positive and significant association with companies that have a disclosure score where there is mandated environmental legislation. Furthermore, there is also a negative and significant association between companies that have a disclosure score under voluntary environmental legislation. Board size remains positive and significant while number of female directors is negative and significant. In this iteration, the Kyoto agreement is positive and significant, suggesting that companies in countries that have signed up to the Kyoto protocol have higher levels of environmental disclosures.

## 5. Discussion

This study investigates the relationship between environmental legislation and GHG emissions. Based on analysis of 57 of the top 100 largest emitters in the world, as per the CDP database, the study finds evidence to support the proposition that organisations that are affected by mandated environmental legislation have comparatively lower levels of greenhouse gas emissions compared with those in countries that do not have such legislation. However, the same does not apply for companies that fall under voluntary environmental legislation. Companies under voluntary disclosures have a positive association with emissions. The association does not change in the presence of the Kyoto agreement.

The analysis finds a very strong association between mandated environmental legislation and GHG emissions, as reported in Table 8. The relationship is negative and significant with a p>0.010. Based on stakeholder theory, it can be argued that organisations required to publish emissions-related information to the public through mandated legislation are affected by a

number of stakeholder groups. Stakeholder pressures from investors, society and the government could have a significant influence on the corporation in achieving some form of legitimacy, given that the companies analysed are global higher emitters. It can, therefore, be argued that this political visibility and stakeholder pressure work towards reducing emissions compared to similar companies not under the same visibility and pressure. Companies required to report emissions mandatorily may feel that by continuously striving to lower their emissions, stakeholders may be better managed, and the political costs that arise from that visibility may be significantly reduced. Given the nature of the emissions disclosures (i.e., being a hard disclosure), companies may not be able to "spin" a story through voluntary disclosures to counter those effects.

On the other hand, when analysing the relationship between voluntary environmental legislation and emissions, the opposite relationship exists. This result is interesting, whereas we would have expected that any type of environmental legislation would have an inverse effect on emissions. The results suggest that there is a positive association, which means voluntary environmental legislation is associated with higher emissions. Some possibilities may be that if there is no mandated impetus to disclose emissions, organisations may not necessarily provide that information for legitimacy and stakeholder management purposes. It may be that organisations may be reacting to environmental legislation via strategic management of disclosure practices, in the presence of voluntary environmental legislation.

In this context, this study provides evidence that compliance with voluntary legislation has no association with reduced emissions; rather, it leads to higher emissions. This result, combined with the finding for disclosures, suggests that companies use disclosure strategies to limit and manage stakeholder relationships. Given the current political and social environment, organisations may perceive greenhouse gas emissions to be sensitive; therefore, while emissions may be high, in situations where there is no mandatory legal framework that requires the disclosure of emissions, organisations may attempt to reduce the perceived importance or sensitivity of the emissions. Secondary stakeholders who may have a significant influence on the organisation may be inclined to relax their scrutiny of the organisation, if they are managed through a lack of disclosure of emissions (under a voluntary legislation regime). In cases where there is renewed visibility, given the dynamic nature of stakeholder groups and the power of the stakeholder groups constantly changing, where there is a lack of mandated environmental legislation, organisations may not attempt to address the reduction of emissions.

In relation to disclosures analysis, H2b was supported, suggesting that voluntary environmental legislation is associated with lower disclosure scores. However, when an extended analysis was conducted using a dichotomous variable using the full sample, both hypotheses were supported. This outcome supports some of the prior literature (Perera et al., 2019), which suggests an association between environmental legislation and disclosures. Given that the companies investigated in this study are the largest global emitters, it may be that stakeholder management through voluntary disclosures may be the primary focus, as opposed to being driven by the existence of environmental legislation. The existence of the Kyoto agreement is not significant, suggesting there is no association between the Kyoto agreement and the level of emissions or the level of disclosures.

## 6. Conclusion

This study finds evidence to support the proposition that mandated environmental legislation has a positive impact on reducing the level of greenhouse gas emissions, while voluntary environmental legislation leads to higher level of emissions. Furthermore, both mandated and

voluntary environmental legislation have an association with environmental disclosures. However, international agreements such as the Kyoto agreement does not have any association with environmental disclosures.

There is significance in this study for policymakers, where the effectiveness of environmental legislation lies in it being mandatory as opposed to voluntary. The presence of mandated environmental legislation drives organisations to try to reduce their emissions due to the negative externalities that are created by such legislation. The political visibility and stakeholder pressure potentially drive the organisation to address high emissions.

Similar to any other study, this study has a number of limitations, one of which is the limited sample size. While we attempted to use the full 100 most polluting companies within the CPD dataset, some of the companies were not listed, and therefore, we were not able to obtain the necessary data for the analysis. Additionally, Bloomberg did not have disclosure scores for almost fifty per cent of the sample. Therefore, the analysis for the corporate disclosure index was limited in terms of the number of observations. The number of observations within each country, in some cases, was limited. However, this was more due to most companies in the top 100 emanating from a few countries.

Further work could be done to expand the number of observations by broadening the scope of emitters. Post 2015, with the introduction of the Integrated Reporting framework, companies have moved towards producing integrated reports. It would also be an interesting future study to look at how <IR> reports have influenced environmental reporting.

Overall, the study is one of the first of its kind to investigate the direct relationship between environmental legislation and the scale of emissions and provides insights into the nature and effectiveness of environmental legislation, both mandated and voluntary, in a global setting.

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