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Effectiveness of Business Practices Related to Climate Change as a Driver for Improving Environmental Performance

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Abstract: This study explores the relation between business practices related to climate change and environmental performance. Using an international sample of analysis from 2013 to 2017, the paper examines how managerial incentives, public policy, disclosure and responsibilities to executives on climate change, as corporate governance factors, affect a firm's environmental performance. By employing several regression analyses, our independent variables-incentives, public policy, disclosure and responsibilities-show to improve the environmental performance in terms of reduction of GHG emissions. In addition, results show that stakeholders' engagement seems less relevant in the US with respect to other countries, this could be related to the US public opinion which exerts lower pressures on companies to deal with climate change. This study contributes to the environmental governance literature, where the impact of governance practices in environmental problem solving has not been widely studied.

Keywords: Corporate Governance, Sustainable Development, Environmental Performance, Climate Change

Introduction

The Sustainable Development Goals (SDGs) recognize that businesses are the main engine of sustainable and economic development and therefore play a key and decisive role. The 2030 Agenda, which includes 17 objectives, clearly judges the unsustainability of the current development model, not only at an environmental level, but also at an economic and social level. In this way, the idea that sustainable development is only an environmental problem was finally overcome, affirming the overall vision of the different dimensions of development (Martínez-Ferrero and García-Meca, 2020). Pursuing the Sustainable Development Goals will certainly benefit the private sector, because companies will have new business opportunities and the ability to strengthen relationships with stakeholders.

One of the great challenges that companies face is to connect the new development to the core business. At this stage, it is essential to build on already solid foundations, orienting each new project towards sustainable development. In the near future, the private sector will become an ever-growing part of global development, which is why it is crucial that companies are progressively involved with international agencies to develop a comprehensive and shared vision on how to monitor and coordinate all stakeholders.

Under the Paris Agreement on climate change, countries are committed to reduce their Greenhouse Gas (GHG) emissions through Nationally Determined Contributions (NDCs) (Rogelj *et al.*, 2016). Under NDCs some countries are instituting cap and trade policy or voluntary commitments from private sectors that require firms to actively manage their GHG emissions (Richards *et al.*, 2016). In addition, some businesses have voluntarily committed to reduce GHG emissions in the absence of government initiatives (Borghesi *et al.*, 2018).

Companies are responding to the problem of climate change in several ways: Purchasing carbon offsets, improving supplier engagement to reduce their own emissions and applying several technological solutions. For example, Bansal (2019) show that oil and gas companies attempted to use new technologies in their production process with the goal of reducing their carbon footprint. Van Vuuren *et al.* (2018) examine the rapid implementation of the best technologies to a deep reduction of GHG emissions. Perry *et al.* (2008) show that the results of renewable technologies consequently reduced the release of CO₂.

Another type of effort to reduce firms' GHG emissions has been placed on corporate governance practices (Aguilera *et al.*, 2018). L'Oréal, for example, created managerial incentives to address climate change by tying executive compensation to GHG reporting scores from CDP, which runs annual greenhouse gas emission disclosures on

behalf of institutional investors. Unilever consider motivating its business divisions by attaching financial and non-financial incentives to the agenda of reducing carbon footprint. Nestlé ensures managerial sustainability and oversees the long-term succession planning of the Board by the Nomination and Sustainability Committee (NSC).

However, empirical evidence on the relationship between governance practices toward climate mitigation and firm's environmental performance in terms of GHG emissions are lacking in the literature. Therefore, in this study, we are attempting to answer the following question:

RQ: Are the level of firm's GHG emissions and the governance practices on climate change related? We examine the relation between corporate governance practices and environmental performance for a sample of 1,612 individual firms across 56 countries. We used both Scope 1 (direct emissions) and Scope 2 (indirect emissions) GHG emissions data from the Carbon Disclosure Project (CDP). We measure corporate governance practices using firms' voluntarily responses to the CDP annual questionnaire.

The remainder of the paper proceeds as follow. The next section presents climate change and private sector. The third section describes the relevant literature corporate governance and environmental performance. The fourth section discusses the research design. The fifth section presents the empirical results. The last section presents discussion and conclusion.

Theoretical Background

Climate Change and Private Sector

Business sustainability is based on the idea that companies must take responsibility for the environmental, social and economic impacts generated by their activities, even at the expense of their stakeholders. The reason for the expansion of the company's responsibilities lies in recognizing the connection between long-term profitability and the socio-economic-environmental context in which it is located (Jadoon *et al.*, 2021).

In 1997, the Greenhouse Gas Protocol (GHGP) was born. It was the result of an initiative by the World Resource Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), which recognized the need of an international accounting standard for greenhouse gas emissions. The WRI and WBCSD believed this would be necessary to track the evolution of international policies on global climate change.

After almost four years, the first edition of the GHGP was published under the name, "Corporate Accounting and Reporting Standards". The GHGP aims to provide companies with a set of tools and methodologies that can be used to calculate their GHG. According to the reporting standards, the emissions must be reported and divided into three categories, called scopes.

Scope 1 emissions are direct emissions that come

from owned or controlled sources by the company. Scope 2 includes indirect emissions that come from the generation of purchased electricity. Scope 3 emissions are all indirect emissions (not included in scope 2) subsumes all other indirect emissions (such as transportation or extraction of purchased materials).

The increase in average global temperature has consequences on the world's ecosystem, leading to a progressive rise in sea levels, the retreat of glaciers and snow cover and an increase in intensity and frequency of extreme weather (Lanfranchi *et al.*, 2014). These issues not only affect the environment, but also economies and the health and mobility of country's citizens.

If action is not taken, by the end of the century, global warming could exceed the 2°C threshold set as a target by the international agreement reached in Paris, France in 2015 (COP 21) and referred to by the UN in the 2030 Agenda. The COP 21 commits European states to continue their efforts to limit the temperature increase to just 1.5°C, while still keeping it below 2°C globally. Europe has already achieved its goal of reducing greenhouse gas emissions by 2020, with industry and energy contributing the most.

The most important corporate sustainability initiative was conceived in 1999, when the then Secretary General of the United Nations (UN), Kofi Annan, addressed the business community in Davos, Switzerland. There he proposed an initiative called the "Global Compact" for sustainability. This pact was launched the following year in New York, NY. The Global Compact was and still is a momentous step for the United Nations, as it not only recognizes the role of businesses as partners in a more sustainable and inclusive developmental environment, but because it directly activates the UN in this private sector engagement project. However, this poses two key questions: How can one distinguish between strategic and tactical choices? And, how can joining the Global Compact as the result of an opportunistic choice based on exclusively reputational needs be avoided?

The main answers to these questions are closely linked to the Global Compact's mission. The first, internal, is related to the fact that sustainability must be strategically integrated into the businesses core by its executives. The second, external and more demanding, concerns the commitment that the company must put on providing a significant contribution to global goals, defined internationally by the UN.

Currently, several countries are adopting the 17 Sustainable Development Goals defined in the 2030 Agenda. The Agenda, which addresses all countries to implement its SDGs, aims to unify nations in the pursuit of creating a more sustainable global-environment, regardless of socio-economic-political status. To achieve this, nations must work together with businesses to develop cleaner energy sources, universal access to clean water, improving infrastructure and the development of the circular economy.

From here we can understand how businesses are called to create value: First, by proposing solutions for a smarter and cleaner economy and secondly, by paying

particular attention to the quality of development.

Particularly, climate change is a key challenge in terms of sustainable development. The warming of the earth's atmosphere is causing changes in the global climate system that threatens all countries. From the survival of large sections of the population in under-developed countries to infrastructure and select economic sectors in developed regions. Furthermore, changes in precipitation and temperature cycles are also affecting ecosystems, such as: Forests, farmland, mountain regions, oceans, as well as the people living there. Global carbon dioxide (CO₂) increased by over 50% between 1990 and 2012.

Climate change is a global issue affecting all nations and the action of governments and its institutions alone will not be enough to provide a remedy. The private sector must play a primary role in combating climate change. Businesses must take responsibility in reducing emissions in a way that is both cost-effective and in-line with their corporate mission and values.

Business benefits go far beyond reducing emissions, companies that are able to assess and understand the risks and opportunities related to the climate will be able to make better decisions over the long term, leading to new business opportunities (Trollman and Colwill, 2021). In addition to communicating the dangers of exposure to harmful emissions (carbon exposure), companies all over the world should make a prediction about the future and what risks they will face. In this context, entrepreneurs must carry out "stress tests" so that the losses related to climate change can be assessed, both in terms of production processes and policies introduced by the company to curb the emissions of GHG.

Hypotheses Development

Climate change and firms' strategies in managing GHG emissions have been discussed in the context of corporate governance (Lee, 2012; Naciti *et al.*, 2021). Kolk and Pinkse (2005) discuss business strategies as a choice between economic interest and firm's responsibility to climate change. The authors identify three strategic options for climate change: Process improvement, product development and new product/market combinations. Jeswani *et al.* (2008) identify the strategies adopted by firms in different sectors focusing on energy-efficiency. Investigate sustainability disclosure tools of Australian firms with reference to corporate governance practices. Their results show that low levels of disclosure of climate change-related corporate governance practices are associated, among other factors, with a lack of proactive stakeholder engagement. Sullivan and Gouldson (2017) examine the effect the external government pressures on corporate strategies and actions related on climate change. Their study shows that internal governance processes on climate change strategies are influenced by external government pressures. However,

firms will be willing to pursue climate change strategies only if financial benefits are expected to exceed related costs.

The effectiveness of these climate change strategies in achieving reductions in GHG emissions, however, has not been addressed by the literature.

Here we build hypotheses on the relationship of corporate governance practices and environmental performance based on stakeholder-agency paradigm (Hill and Jones, 1992).

In the traditional paradigm on agents and principals, the stakeholders' interests can diverge from managers' strategies to allocate the firm's resources (Lee, 2012). Accordingly, the literature on corporate governance and environmental management suggests that stakeholders' interests and corporate governance's preferences may diverge because stakeholders show a greater interest on climate change than the interest shown by managers (Bansal, 2005; Sharma and Henriques, 2005; Cordova *et al.*, 2021). Nevertheless, according to Hill and Jones (1992), managers have to propose strategic decisions and allocate resources in order to guarantee stakeholders' interests are addressed. In short, managers are understood as agents of stakeholders within an implicit contractual relationship and corporate governance process is the main mechanisms through which conflicting interests are solved (Hill and Jones, 1992). Following the stakeholder-agency paradigm, corporate governance practices reduce the gap between the interests of agents and principals, increasing the willingness of managers to satisfy the environmental preferences of stakeholders. In this study four specific practices for climate change and the reduction of GHG emissions were considered: (1) Instituting managerial incentives, (2) engaging in public policy on climate change, (3) disclosure of organization's response to climate change and GHG emissions and (4) assigning climate change-related responsibilities to executives.

Incentives are the most diffused corporate governance practices to align the interests of stakeholders with those of the managers (Zajac and Westphal, 1994; Nakazato *et al.*, 2011). Several studies have examined the role of managerial incentives on firm's performance (Agarwal *et al.*, 2009; Hall and Murphy, 2003; Coles and Li, 2018; Villena and Dhanorkar, 2020; Galletta *et al.*, 2021). Banerjee and Homroy (2018) analyzed the effect of managerial incentives in alignment strategic objectives of managers and stakeholders and found that ownership structure affects the incentives optimizing strategies on firm's performance. Castellaneta (2016) investigates the relationship incentives and competitive advantage through capability building. The study shows how managerial incentives effect three different areas of firm capabilities, which are the main drivers of competitive advantage. Moreover, Cao *et al.* (2019) show how managerial incentives are related to compensation policy and firm performance. In particular, the study finds that promotion in career exhibits a strong positive relation

with firm performance.

In the context of climate change, we hypothesize that these effects of managerial incentives improve the propensity of managers in making decisions on environmental issues. On the one hand, an improvement in environmental performance is often associated to improved financial performance (Chen *et al.* 2006; Gök and Peker, 2017). On the other, managerial incentives also increase the ability of stakeholders to exert pressure on managers toward environmental issues. Therefore, we hypothesize that:

H1: The presence of managerial incentives for climate change is positively related to firm's environmental performance

Public policy is an important driver to align managerial and stakeholder interests (Hill and Jones, 1992; Osemeke and Adegbite, 2016, Čábelková *et al.*, 2021). While new climate change policies, such as carbon tax or emissions cap, may negatively affect the company's financial performance (Fankhauser *et al.*, 2016), they create a responsibility for managers to comply with the new policy, which enables stakeholders to assert their interests (Hillman and Hitt, 1999). For example, the Sarbanes-Oxley act of the U.S., also known as Public Company Accounting Reform and Investor Protection 2002, has made managers' responsibilities grow exponentially, including environmental responsibility. In this case, exposure to new policies that are aligned with stakeholders' interests allows managers to act on behalf of the stakeholders in order to reduce the risk associated with their responsibility (Lankoski, 2006). Therefore, we hypothesize that:

H2: Exposure to public policies on climate change is positively related to related to firm's environmental performance

According to Ullmann (1985), stakeholder power is an important consideration in the firm's operation, such that stakeholders can influence business objectives. Active engagement of stakeholders represents an important corporate governance mechanism (Graziano and Luporini, 2003), which is being used to influence corporate governance in the social, environmental area (Solomon and Solomon, 2006; Gonzalez-Urango and García-Melón, 2018). The process of stakeholder involvement concerns specifically the communication and iterations between the company and the stakeholders (Pulejo *et al.*, 2017; Calveras and Ganuza, 2018). The involvement of investors, in particular, has substantial effects for corporate governance practices and corporate reputation (Foster and Jonker, 2005). The involvement of stakeholders brings immediate advantages in terms of image, improving the reputation of the company with undisputed commercial and relationship benefits. In the

context of climate change, managers can modify the firm's strategic direction under the pressure of some specific stakeholder groups, who can press on their environmental interest to influence firm's behavior. Therefore, we hypothesize that:

H3: The presence of initiatives that engage climate change-related stakeholders is positively related to related to firm's environmental performance

The board of directors has legitimacy to exert pressure on managers in monitoring stakeholders' interests (Fama and Jensen, 1983; Jensen and Meckling, 1976). Independent directors, for example, should act protecting shareholders interest as well as the other stakeholders' preferences. Several studies have shown that certain compositions of a board of directors can influence firm environmental and social performance (Arena *et al.*, 2015; Jizi, 2017; Cucari *et al.*, 2018; Pucheta-Martínez and Chiva-Ortells, 2018; Naciti 2019). Post *et al.* (2015) show that a board of directors with a higher presence of independent directors has a higher regard for environmental issues.

Moreover, Kassinis and Vafeas (2002) argue that some directors, who do not directly represent a specific stakeholder, will probably defend the interest of environmental stakeholders. If the responsibility for climate change issue is entrusted to the board of directors, the degree of pressure that stakeholders exert on managers may grow in the presence of directors who represent the interests of stakeholders. Therefore, we hypothesize that:

H4: The presence of a responsibility on climate change entrusted on the board of director is positively related to firm's environmental performance.

Research Design

Sample and Data

Following prior research (Stanny E., 2013; Kim Y., 2013; Matisoff D. C., *et al.*, 2013, Blanco *et al.*, 2020), we use Carbon Disclosure Project (CDP) dataset from years 2013-2017, which contains 8,060 unique firm-year observations from 1,612 individual firms across 56 countries. CDP is a private, not-for-profit organization launched in 2000; it runs a system that offers companies and countries the possibility of measuring, detecting, managing and sharing information on their greenhouse gas emissions at a global level with the aim of improving their carbon footprint. Companies that want to be classified in the CDP must respond to a questionnaire that detects the actions taken, objectives and strategies in the field of climate change management. Furthermore, answering the questionnaire and obtaining a good score brings to companies' great visibility on a global level,

thus stimulating the interest of the increasing number of institutional investors who include ESG (Environmental, Social and Governance) issues in their investment choices. Since 2003, CDP has annually distributed questionnaires to the largest listed firms around the world, such as listed firms of the S and P 500 index and Global 500 index (Kolk *et al.*, 2008). The questionnaire is organized in categories such as governance, strategy, risk management and emissions performance and it consist of a series of questions to which a firm responds by selecting a discrete choice from a drop-down menu or providing numerical data and text in details about its policy or strategy.

From the questionnaires we have extracted information regarding the quantity of GHG emissions produced (Scope 1 and Scope 2) and the corporate governance practices implemented. We complemented these data with financial data from the same period extracted from Compustat. The collected information has allowed us to build a panel dataset.

Variables and Model

Table 1 describes the dependent, independent and control variables.

Dependent Variable

Environmental performance is the independent variable. For each reporting year, companies responding to CDP questionnaires provided information on gross global Scope 1 and 2 (combined and non-combined) emissions, measured in metric tons of CO₂ per unit currency of total revenues. It was not possible to include Scope 3 due to the paucity of data. In line with previous studies (Wang *et al.*, 2014; Marcotullio *et al.*, 2013), the logarithmic form of the total Scope 1 and 2 GHG emissions was utilized.

Independent Variables

To test the hypotheses, following prior studies four questions from the CDP questionnaire were selected (see appendix):

- Incentives is a dummy variable that is equal to 1 if the firm provides incentives for the management to address climate change and GHG emissions and 0 otherwise
- Public Policy is a dummy variable that takes the value of 1 if the firm engages in activities that could influence public policy on climate change and 0 otherwise. This variable represents a proxy of the influence that climate-related policies have on firms, under the assumption that firms engage in climate-related activities to influence public policies if they are affected by existing policies or expect to be affected by future policies

- Disclosure is a dummy variable that takes the value of 1 if the firm publishes information about the organization's response to climate change other than in CDP response and 0 otherwise. This variable represents a proxy of stakeholders' engagement, which is stimulated by the firm's effort to communicate and disclose information about the firm's actions to address climate change
- Responsibility is a dummy variable that takes value of 1 if the highest level of direct responsibility is entrusted to the board of directors or to the senior manager and the value of 0 if there are no individual board members or committees with overall responsibility for climate change

Control Variables

This study controls for several variables effecting the company's GHG emissions.

Consistent with previous studies (Brammer and Pavelin, 2008; Stanny and Ely, 2008; Clarkson *et al.*, 2008), controls were placed on Size, Leverage and Price-to-Book. Size has been measured by taking the natural log of total assets; Leverage is calculated by Debt-to-equity ratio and Price-to-Book is estimated as market value divided by book value of equity. Following the study of, the control for industry was introduced by creating a High-carbon dummy variable that takes the value of one, if a firm belongs to a high-carbon-impact industrial sector (automobiles and components, chemicals, forest products, gas and electrical utilities, oil and gas, mining, pipelines, precious metals, steel and transportation) and zero otherwise. Moreover, we account for organization fixed effects and control for time dummy variables.

Model

The model examines the effects of corporate governance practices addressing climate change by focusing on GHG emissions. To examine such effects, several variations of cross-sectional time series data are used. The following multivariate analysis model is used:

$$Y = \alpha + \sum_j \beta_j CGPractice_j + \sum_k \gamma_k Control_k + \varepsilon \quad (1)$$

where:

- Y = Natural logarithm of firm's GHG emissions
- A = intercept
- β_j, γ_k = Coefficients to be estimated
- CG_Practices = Set of corporate governance practices
- Controls = Set of firm level controls
- ε = Error term

Table 1: Variables Description

Variable	Description	Source
Envperf	Calculated as the logarithm of total emissions	CDP questionnaires
Incentives	Dummy variable that is equal to 1 if firm provides incentive for the management	CDP questionnaires
Public POLICY	Dummy variable that is equal to 1 if the firm engages in activities that could influence public policy	CDP questionnaires
Disclosure	Dummy variable that is equal to 1 if the firm publishes information about the organization's response to climate other than in CDP response?	CDP questionnaires
Responsibility	Dummy variable that is equal to 1 if the highest level of direct responsibility is entrusted to the board or senior manager	CDP questionnaires
Size	Natural log of total assets	COMPUSTAT
Leverage	Debt-to-equity ratio.	COMPUSTAT
Price-to-book	Price to book value of equity.	COMPUSTAT
High-carbon	Dummy variable that is equal to 1 if the firm belongs to a high carbon impact industrial sector	CDP questionnaires

Results

Descriptive Statistics

Table 2 presents number of companies, emissions and firm size with industry breakdowns. The sample comprises 1,612 firms across 11 industries. Among them, the sector Industrials with 339 companies represents 21% of the sample, followed by Materials with 12%, which also has the highest level of emissions. Banks and Financials industries represent 18% of the total sample, with lower emissions an average as compared to other industries.

Multivariate Analysis

The relationship between corporate governance practices and GHG emissions was estimated by Eq (1). Table 3 reports outcomes of the multivariate regression for the pooled sample in the span period 2011-2015. Model 1 shows the basic regression, where year fixed effects are not considered. We can see that Incentives, Responsibility and Disclosure are negative and statistically significant at the 5% level, suggesting that firms that apply these types of practices produce lower GHG emissions. The variable Public Policy is statically insignificant. When year effects were included in Model 2, the variables Incentives, Responsibility and Disclosure remain negative and statistically significant at the 5% level.

Furthermore, Models 3 and 4 show regression results by separating firms into US and non-US, respectively. Results show that in US firms only Incentives and Responsibility are significantly and negatively associated with GHG emissions at the 5% level. While, looking at non-US firms, Incentives, Responsibility and Disclosure continue to be negative

and statistically significant at the 5% level. Moreover, unlike Models 1-3, Public Policy comes out to be negative and statistically significant at the 10% level. These findings provide weak support for Hypothesis 3, suggesting that engaging in activities to influence public policies on climate change is associated to lower GHG emissions in some countries, but not in others, depending on the sensitivity of the country's political system to respond to pressures from interest groups.

This table reports regression results of environmental performance on variables representing corporate governance practices and all others are control variables. The sample consists of 8,060 firm-year observations from 56 countries over the period 2011-2015. Environmental performance is the dependent variable, estimated as the logarithm of total GHG emissions. Standard errors clustered at the individual level in parentheses. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$. To ensure robustness to the results, several sensitivity tests were performed (Table 4). The basic equation was re-run by using a quantile regression to better control for the presence of outliers (Model 1 Table 4) and a panel fixed effects regression to control for the unobserved fixed effects that are associated with each firm (Model 2 Table 4). Namely, when the unobserved effect is correlated with the independent variable, pooled OLS produce estimators that are biased and inconsistent. In corporate governance studies, De Andres and Vellelado (2008) suggest using either the first differences or the fixed effects (within) estimators. Using either the quantile regression or fixed effects regressions does not affect the results.

Another problem inherent to the empirical analysis is the endogeneity issue. Endogeneity refers to situations in which an explanatory variable is correlated with the error term. This can arise for three

common causes: Reverse causality, omitted variables and measurement errors. Reverse causality means two variables are jointly determined. For example, if we have two variables X and Y and they are jointly determined, then it means X causes Y and Y causes X (Baltagi, 2008). In order to check whether the regression suffers from reverse causality, the best solution is to re-estimate the model using lagged independent variables. If the sign of the independent variables changes and is significant, this means that the regression suffers from reverse causality; if there are no changes in the sign of the independent variables, then we can rule out reverse causality.

In line with previous studies (Busch *et al.*, 2012;

Lewandowski, 2017; Delmas *et al.*, 2015; Trumpp and Guenther, 2017), the independent variables was lagged by one year to address the presence of endogeneity (Model 3 Table 4). When we estimate the regression with lags t-1 of independent variables as instruments, the core results remain qualitatively unaffected.

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Table 2: Industry descriptive data

Industry	No. of companies	Size	Log GHG emissions
Banks	114	12.46	4.65
Consumer Discretionary	188	11.65	5.40
Consumer Staples	110	14.38	6.18
Energy	97	11.43	6.46
Financials	182	15.12	4.72
Health Care	96	15.68	5.79
Industrials	339	10.67	6.11
Information Technology	141	12.55	5.66
Materials	192	14.72	6.73
Telecommunication Services	51	10.46	4.77
Utilities	102	10.27	5.71
Sample	1,612	12.67	5.65

Table 3: Corporate governance practices and GHG emissions

Model	1	2	3	4
Incentives	-0.768 ** (0.145)	-0.813** (0.094)	-0.437** (0.072)	-0.673** (0.089)
Public policy	-0.076 (0.003)	-0.050 (0.002)	-0.092 (0.001)	-0.166* (0.002)
Disclosure	-0.437** (0.041)	-0.672** (0.037)	-0.361 (0.027)	-0.382** (0.040)
Responsibility	-0.326** (0.016)	-0.546** (0.021)	-0.316** (0.013)	-0.268** (0.015)
Size	2.561 (0.172)	2.536* (0.164)	2.167* (0.128)	2.376* (0.164)
Leverage	0.146 (0.010)	0.184** (0.034)	0.201** (0.018)	0.143* (0.024)
Price-to-book	1.076 (0.181)	1.074 (0.172)	1.041 (0.134)	1.069* (0.183)
High-carbon	0.076** (0.011)	0.135** (0.018)	0.137** (0.012)	0.214** (0.016)
Constant	0.161*** (0.042)	0.134*** (0.036)	0.163*** (0.037)	0.142*** (0.055)
Year fixed effect	No	Yes	Yes	Yes
Adj.R2	0.424	0.432	0.322	0.394
N. obs	8,060	8,060	1,980	6,080

Table 4: Robustness check

Model	1	2	3
Incentives	-0.347*** (0.006)	-0.484** (0.034)	
L. Incentives			-0.322** (0.156)
Public policy	-0.349 (0.011)	-0.088 (0.174)	
L. public policy			-0.139 (0.192)
Disclosure	-0.347* (0.012)	-0.523** (0.239)	
L. disclosure			-0.111* (0.135)
Responsibility	-0.463*** (0.005)	-0.375** (0.155)	
L. responsibility			-0.234** (0.125)
Size	3.648 (0.001)	2.636* (0.034)	2.492 (0.051)
Leverage	0.137** (0.063)	0.364* (0.031)	0.137* (0.074)
Price-to-book	1.149** (0.042)	1.124 (0.137)	1.346* (0.137)
High-carbon	0.522*** (0.006)	0.471* (0.012)	0.267* (0.023)
Constant	0.234*** (0.016)	0.326*** (0.037)	0.367*** (0.022)
Fixed effect	Yes	No	Yes
R2	0.367	0.436	0.367
N. obs	8,060	8,060	6,448

Conclusion

In this study, we analyzed the relationship between corporate governance practices and climate change using a multivariate analysis applied to the 2011-2015 GHG emissions dataset from 1,612 firms across 56 countries in 11 industries. Overall, the analyses provide meaningful results. First, we find that firms that provide incentives to their management to address climate-related issues are negatively related to the amount of firm's GHG emissions. This result is in line with Jensen and Meckling (1976) and Kock *et al.* (2012) that showed positive relationship between managerial incentives and firm's environmental performance.

Secondly, we find that the companies that involve stakeholders in the formulation of their policies or corporate strategies are negatively related to GHG emissions. This negative relationship is in line with the study by Foster and Jonker (2005), which showed that sustainability is a business management model that, through stakeholder engagement, improves firm performance by maximizing reputation and value. Moreover, the results show that firms in which the highest level of direct responsibility is entrusted to the board or senior manager are negatively related to GHG emissions. This finding is in line with Fama and Jensen (1983), who argued that board acts in favor of protecting and managing stakeholders' interests.

Overall, research outcomes suggest that firm's governance practices on climate change and the amount of GHG emissions or the GHG emissions intensity are closely related.

A further analysis was conducted by dividing the full sample into US and non-US firms. When we estimate the regression only with US firms the coefficients for Incentives and Responsibility remain negative and statistically significant, but the independent variable Disclosure is not significant. By contrast, when we estimate the regression considering only non-US firms, all the independent variables are negative and statistically significant. Since Disclosure measures whether a company informs its stakeholders about activities performed in response to climate change, the results suggest that the relevance of stakeholders' engagement is country specific. In particular, stakeholders' engagement seems less relevant in the US with respect to other countries (Table 3 model 3), either because the overall information system is more developed in the US (and thus individual companies' communication activity is less relevant), or because the US public opinion exerts lower pressures on companies to deal with climate change.

The study contributes to the literature on corporate governance and climate change in several ways. First, the study offers evidence that firms' GHG emissions and governance practices are related. Previous studies

(Hussain *et al.* 2018; Bassen and Kovacs, 2020; Kassinis and Vafeas, 2002; Centorrino and Naciti, 2019) were focusing on the relationship between corporate governance and general sustainability performance, but, to the best knowledge, the relationship between firms' GHG emissions and governance practices has not been addressed.

Second, by taking a stakeholder- agency theory perspective proposed by Hill and Jones (1992), the paper confirms the existence of a direct link between stakeholders and corporate governance. The threat of damaging activism that can be brought on by stakeholders has an influence on the decision-maker's environmental strategies, which in turn is influenced by corporate governance practices. Overall, the study contributes to stakeholder-agency literature by exploring the way in which corporate governance practices mitigate conflicts between stakeholders and managers in relation to environmental issues.

Third, we found a difference between US and non-US firms. One potential reason of this finding is that the political system and the authority of government can influence the decisions of managers (Galbreath, 2010; Ammons and Roenigk, 2020). For Example, European governments have been more involved in sustainable activity addressed to climate change (Aguilera *et al.*, 2018). Also, the US shareholder model of corporate governance tends to place profits maximization as the main business goal rather than commitment in social activities such as climate change. Moreover, according to the institutional theory, organizational practices become spread and homogenize due to three forces, namely coercive, mimetic and normative. By examining the presence of these three forces it is possible to explain convergence on organizational practices and behavior.

Furthermore, the study contributes to the environmental governance literature (Kassinis and Vafeas, 2002; Kock *et al.*, 2012), where the impact of governance practices in environmental problem solving has not been widely studied. The results show that instituting certain corporate governance mechanisms can address climate change problem.

However, these results should be interpreted in the context of their limitations. First, the sample includes only large firms, since it is limited to CDP respondents. As most academic climate change databases that offer information mainly for listed companies, in CDP small and medium-sized enterprises are limited, since they show a series of difficulties in implementing strategies on climate change. Furthermore, CDP respondents voluntarily respond to the survey, so that the sample could suffer from self-selection bias (Luo and Tang, 2016). However, future research could investigate both

CDP respondents and companies that do not follow a CDP approach.

Sec we did not consider the possibility that other variables could intervene in the associations among corporate governance practices and GHG emissions. It is possible, for example, that other corporate governance dimensions influence the causal links among the model variables.

Moreover, the sample includes companies from 56 countries which differ in their government policies and initiatives addressed to climate change. However, future studies could take into account the effect of institutional environments and differences based on different cultural aspects.

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Author's Contributions

This paper is the result of a joint effort of all the authors who contributed to the following parts of the manuscript.

Valeria Naciti: Theoretical Background; Research Design and Results.

Giovanna Centorrino: Introduction and Conclusion

Ethics

This article is original and to the best knowledge of the author has not been published before. Authors declared that there are no ethical issues that may arise after the publication of this manuscript.

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