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Influence of Cultural and Environmental Values of CEOs on Greenhouse Gas Emission Intensity

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Abstract: The main objective of this study is to examine the influences of two novel characteristics of the foremost executive firm managers, i.e., the environmental and cultural values of CEOs, on corporate climate change performance. Employing a sample of firms listed in the FTSE250 covering the 2008–2018 period, we found that firms run by CEOs with environmentally friendly backgrounds and high 'green' cultural values are more inclined to aim for better (lower) greenhouse gas emissions. The findings hold after accounting for other relevant governance characteristics, accounting and market indicators, highly carbon-intensive industries, and potential endogeneity issues. Intriguingly, we also found that the effect of CEO environmental values is more pronounced than that of CEO cultural values. Our findings have implications for corporate management and regulators of climate change concerns and corporate environmental performance. That is, firm management is advised to assign CEOs with environmentally friendly backgrounds and high 'green' cultural values to lower greenhouse gas emissions.

Keywords: CEO culture; environmental value; environmental performance

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1. Introduction

In the last two decades, people's behaviours and their environmental impacts have received global recognition. Various recent environmental responses, such as climate change, global warming, loss of biodiversity, ozone depletion and tropical deforestation, have indicated that environmental problems are far from being solved. The drastic change in environmental conditions has prompted several national and international organisations to develop a keen interest in the subject matter. Climate change has also drawn great attention and interest from the media and investors, which motivates firms to improve their environmental performance [1,2]. The escalating threat of climate risk, fueled by extreme weather events, poses a significant danger to human wellbeing, assets, and even lives. This pressing issue has spurred various actors, particularly within the corporate sector, to embrace a transition toward low-carbon emissions, recognising the urgent need to mitigate this global challenge [3]. With the rise of the mass environmental movement and global awareness of environmental concerns, social scientists have begun to carry out studies to understand people's attitudinal dispositions toward environment-related issues. Furthermore, in recent years, many ecologically minded organisations and agencies around the world have formulated action plans for altering laws, raising awareness of the importance of ecological balance and changing people's attitudes toward safeguarding the environment [4,5]. Particularly, Winter and May [6] noted that environmental policy scholars and policymakers have long been interested in distinguishing the different mechanisms that encourage environmental protection by the private sector.

In a corporate setting, the Upper Echelons perspective indicates that the behaviours and management practices of the Chief Executive Officer (CEO) are associated with a

firm's performance and environmental behaviours [7]. The characteristics and dispensation of the organisation as a whole body are largely influenced by the CEO, who is typically responsible for making strategic choices, such as those that involve the selection of the firm's long-term environmental management. A substantial amount of prior literature has reported the significant impacts of the CEO's age and educational background on a firm's corporate social responsibility in general and on environment-related matters in particular [8–11]. For instance, Almulhim and Aljughaiman [12] showed that CEO attributes, such as CEO gender, education, and tenure, influence the relationship between the environmental, social, and governance (ESG) level and corporate performance.

With the aim of attaining an in-depth understanding of the impact of the characteristics of the CEO on an organisation's environmental behaviours, the current study explores the potential influences of the cultural and environmental values of the CEO on corporate climate change decisions, i.e., greenhouse gas (GHG) emission intensity. The effects of GHG emissions on climate change and global warming have motivated an increasing body of corporate literature to explore the channels through which firms can improve their 'green' performance for their 'green' stakeholders [13]. The topic is critical at the corporation level as firms are now more aware of the intensified scrutiny and expectations of many international pro-environmental groups, the media, and stakeholders of industrialised countries with regard to corporate environmental strategies [14–16]. Despite a thorough literature review, the association between CEO environmentalism and culture and firm GHG intensity remains unclear. Nevertheless, a related study conducted by Li et al. [17] demonstrated that strong CEO networks lead to improved carbon performance within companies. They suggested that close social ties between CEOs and their top management teams (TMTs) can actually enhance resource allocation, rather than exacerbate existing agency problems. Additionally, CEOs facing negative media exposure are more likely to implement significant corporate sustainability measures. They also indicated that operating in regions with high carbon emissions encourages CEOs to acquire carbon-related knowledge through their social networks. Luo and Tang [18] indicated an association between national culture and a firm's carbon disclosure propensity. Particularly, they reported the significant impacts of the five cultural dimensions of Hofstede [19], i.e., masculinity, power distance, uncertainty avoidance, individualism, and long-term orientation, on a firm's carbon disclosure. Notably, their findings primarily compared the environmental disclosure levels of firms in different cultural nations and hence did not allow for heterogeneity across firms within the same country. It has been argued that national culture manifests itself in social norms related to environmental matters. Therefore, a CEO's personal judgements, attitudes, and subjective perceptions toward these issues may be inherited from their rooted national culture, which subsequently affects their corporate environment-related decisions and choices [18,20–22].

Extending this research stream, our study examines the impacts of the personal, cultural, and environmental values of CEOs on the GHG emissions of firms. Both the dependent and independent factors studied possess academic and practical value-added perspectives. Firstly, the concept of firm environmental performance is acknowledged to be as important as the concept of environmental disclosure, and the two should therefore be examined independently. Particularly, it may be sensible to think that greater transparency through higher environmental disclosure would be rewarded by the market. Nevertheless, market reactions can be negative following an environment-related disclosure, which may be due to the negative environmental figures that firms produce [23–25]. This implies that market participants may place higher focus and weight on a firm's actual environmental performance rather than on its disclosure frequency/quantity. As quoted by EnergyWorld [26], "over the long-term, companies from the carbon-intensive sectors that fail to take proper recognisable emission abatements may be expected to experience fundamental devaluations in their stock when the climate change risk gets priced correctly by the market".

Second, regarding the personal cultural values of CEOs, although Ferris, Jayaraman and Sabherwal [27] suggested that the CEO's cultural beliefs may be influenced by the national culture of the country where the company is headquartered, such personal cultural transitions remain conditional on various external environmental conditions surrounding the CEO. As a result, it is pertinent to study the impact of the CEO's cultural background, referred to by Ferris et al. [27] as 'traditional' culture, on corporate environmental decisions, particularly GHG emissions. In this study, we focus on all six Hofstede [19] cultural dimensions in the measurement of CEO cultural values. Additionally, the study also examines the environmental values of CEOs embedded in their original countries. Specifically, we investigate the differences in the emission levels of firms led by CEOs from countries with a high Environmental Performance Index (EPI) and those led by CEOs from lower EPI countries.

The influences of national values and cultural backgrounds on individual attitudes, mindsets, and behaviours have been extensively explored across disciplines, including sociology, psychology, and management [19,28]. An individual born and raised in an environment that endorses and encourages specific norms and values tends to internalise these influences, subconsciously shaping their mindset and values as they assimilate within their respective groups [29]. Drawing on this foundation, our hypotheses posit that CEOs from cultures and backgrounds that prioritise environmental concerns are more inclined to support initiatives aimed at protecting the environment. Consequently, firms that are led by these environmentally conscious CEOs are expected to exhibit more eco-friendly practices, including lower greenhouse gas (GHG) emissions. The green background as an influence on green behaviours has been supported by various studies, such as Huang et al. [30], Hershfield et al. [31], and Husted [32]. These studies highlight how an individual's cultural and value systems can shape their pro-environmental attitudes and subsequently influence the environmental orientation of the organisation they lead.

We employ a sample of FTSE250 firms covering the period from 2008 to 2018. The final sample contains 1496 firm-year observations. Both measures of CEO environmental and cultural values are derived from CEO nationality, with the former being proxied by the EPI and the latter being proxied using the six cultural dimensions of Hofstede [19]. Employing the baseline Ordinary Least Square (OLS) robust estimation, together with other models to control for potential endogeneity issues (i.e., lagged approach, GMM, 2SLS), we consistently found that CEO environmental and cultural values were significantly and negatively associated with GHG emissions. In other words, firms operating under the leadership of CEOs from countries with high EPIs and 'greener' cultures tend to produce fewer GHG emissions. Intriguingly, the results also revealed that the effect of environmental values is more pronounced than that of green cultural values.

Overall, the contributions of the current research are two-fold. Firstly, to the best of our knowledge, this is the first study to investigate the impacts of CEO cultural and environmental values at the individual level, allowing for cultural heterogeneity within a nation across different companies, on firm environment-related characteristics. Secondly, the study extends the extant culture-environment literature by emphasising firm environmental performance.

2. Theoretical Background and Literature Review

2.1. CEOs and Corporate Environmental Decisions

In the 1980s, addressing the question of why it is critical to focus on the socio-demographic characteristics of strategic leaders, Hambrick and Mason [33] proposed the seminal Upper Echelons Theory (UET), in which organisations become reflections of their top managers. In other words, the theory suggests that both the strategies and effectiveness of organisations "are viewed as reflections of the values and cognitive bases of powerful actors in the organisations" [33] (p. 193). The theory is built on two connected assumptions: (i) organisational top decisionmakers make decisions on the basis of how they personally

interpret their strategic contexts; and (ii) the way these senior managers understand reality through their personality, cognition, experience, and beliefs.

The key rationale here is that organisational governance is a complex activity in which the socio-demographic features of top decisionmakers can act as good proxies of their cognitive values, despite being physiologically incomplete. The socio-demographic variables that Hambrick and Mason [33] originally introduced as proxies are: (i) age, (ii) education, (iii) gender, (iv) job-related experiences, (v) socio-economic background, (vi) financial circumstances, and (vii) culture. The study also developed theoretical propositions about the potential relationship between those variables and firm outcomes. For example, the authors found that: (1) organisations with young top decisionmakers, on average, tend to adopt more risk-inclined strategic decisions; (2) organisations with homogeneous rather than heterogeneous dominant coalitions are quicker at making decisions; and (3) product innovation is facilitated when the top managers are highly educated.

Overall, the theory suggests that the personal attributes of the top decisionmakers are enduring characteristics that reflect firm outcomes, e.g., financial and environmental performance, and corporate strategies and effectiveness. Notably, the literature has documented the essential roles of CEOs in shaping the sustainable and environmental strategies of firms, i.e., their environmental policies and practices [12,17,34–36]. Furthermore, CEOs are also responsible for the deployment of the financial resources of firms, which can be distributed to implement long-term strategic environmental management [37]. Moreover, the decisions taken by corporations regarding environmental investments hold significant weight in protecting the public environment. As the individual responsible for both decision-making and execution, the CEO's environmental awareness and sense of social responsibility exert a long-term influence on the company's strategy for protecting the environment [38].

Therefore, scholars and practitioners currently consider the exploration of specific personal demographic and social-economic attributes of CEOs, e.g., age, education, and culture, as a particularly promising area both to understand how the dynamics internal to dominant coalitions effectively work and to capture their overall impact on organisations and their environmental dispensation.

2.2. CEO Environmental Values and Firm Greenhouse Gas Emissions

The literature has widely documented the cross-national differences in environmental concerns and attitudes toward safeguarding the environment [4]. In the study carried out by Hershfield et al. [31], it was reported that individuals from long-standing countries and countries with high EPIs tend to have positive attitudes and concerns toward the environment. More specifically, each country exhibits an EPI that measures the concerns, attitudes, efforts, and behaviours toward environment-related matters [39]. The authors proposed that individuals from countries with a long history of existence tend to have a longer time horizon into the future (i.e., a more reliable connection to the future generation), and hence, these countries exhibit higher EPIs. The citizens are more environmentally friendly with more influential pro-environmental behaviours, e.g., they donate more to environmental projects. Consequently, adding to the corporate governance and environmental literature, the current study proposes that CEOs from countries with high EPIs are more likely to inherit 'green' attitudes from their origins, thus adopting more environmentally friendly strategies, and improving the environmental performance of firms with lower GHG emissions. Therefore, the following hypothesis is developed and tested:

H1. *Firms led by CEOs from high-EPI countries exhibit significantly lower GHG emissions.*

2.3. CEO Culture and Firm Greenhouse Gas Emissions

The actions and decisions of individuals, firms, and other bodies are undoubtedly tied to a number of underlying factors. These factors are without doubt responsible and indispensable for explaining the 'what, why, and how' regarding human decisions. Identity formation and loyalty to one's origin have been two of the most interesting

constructs of debate in behavioural science. Hofstede [19] (p. 12) defined culture as the collective programming of the human mind and "the crystallization of history in the minds, hearts, and hands of the present generation". Within the manifestation of culture, different psychological processes and behavioural patterns can be observed [40].

Values are the outcome of the culture and ethnicity of a society from which an individual originates and identifies [41]. When discussing attitudinal dispositions, the cultural context from which an individual emanates must be taken into consideration, as it shapes one's ethical beliefs or morals [29]. An example of a study linking cultural backgrounds to individual pro-environmental value orientations is the study by Soyez [42]. Her studies were conducted in four Western countries and Russia, and they showed that the influence of a pro-environmental value orientation differed substantially according to the individual's cultural values. Furthermore, Gould, Krymkowski and Ardoin [43] tested the connectedness to nature and self-efficacy constructs, and the result emphasised the importance of addressing ethnicity and culture in environmental thoughts and actions.

To further explain a nation's attitude toward environmental behaviours and to provide a holistic view of the topic, environmental psychologists have been learning about individuals at the micro level in order to provide better research-based evidence on the cultural backgrounds of individual dispensations to environmental issues. Different cultural lifestyles reflect environmental behaviours in different ways [44]. Hofstede [19] offered support for this idea with his cultural dimensions, which have been widely employed in various fields of the social sciences, including psychology, anthropology, and sociology, as well as economics and finance. The literature has suggested the influences of those cultural dimensions, comprising individualism, power distance, uncertainty avoidance, masculinity, long-term orientation, and indulgence, on an individual's concerns and attitudes toward the environment. In this study particularly, these Hofstede values are examined in relation to CEOs.

Individualism-Collectivism: According to Hofstede [19], different cultures adopt different family structures. Societies in which members exhibit the 'we' identity rather than perceiving their personal identity as 'I' are referred to as collectivist societies. In this culture, individuals possess strong links with one another and value the group's interests more than their own personal interests. On the other hand, members of individualistic societies perceive themselves as distinct identities that are different from other individual/group identities. Regarding environmental matters, Jaggi and Low [45] suggested that individualistic societies tend to disclose more, which leads to more discussion and disclosure of environmental matters with groups concerned about the environment, and hence raises stronger public awareness about ongoing issues. Therefore, individualistic managers tend to exhibit stronger ecologic accountability through more proactive green strategies [32]. Consequently, it is expected that a higher individualism index is associated with a 'greener' culture, meaning that more individualistic CEOs are likely to achieve lower levels of GHG emissions for their firms.

Masculinity-Femininity: This cultural continuum focuses on the emotional roles between genders [19]. Masculine societies place more emphasis on achievement, assertiveness, material rewards for success, and heroism. Hence, these societies tend to be more competitive. On the other hand, the feminine side of this dimension tends to emphasise cooperation, quality of life, and modesty [19].

Environmentalism, involving taking conscious efforts to sustain the environment, is perceived as feminine behaviour. It is often associated with caring, nurturing, and a focus on quality of life, which are seen as feminine behaviours. Hofstede [19] (p. 32) and Van der Laan Smith, Adhikari and Tondkar [46] (p. 133) stated that masculinity focuses more on economic growth, careers, and financial goals than environmental sustainability. Furthermore, ecofeminism suggests that feminine individuals are more active than their masculine counterparts regarding environmental issues for a variety of social, cultural, and biological reasons [32,47]. In the corporate context, Zhang et al. [48] posited that feminine CEOs are associated with more sustainable environmental policies within corporations

due to their inherent communal qualities and greater tendency to prioritise stakeholder interests compared to masculine CEOs. Van der Laan Smith et al. [46] and Luo and Tang [18] found that firms in highly masculine cultures tend to disclose less information about social matters. In other words, lower masculinity is associated with a greener culture. Taking this all together, it can be predicted that CEOs with higher masculine cultural values (lower femininity) are less likely to pursue preservation of the environment as their priority, hence they are less conscious about the impacts of their environmental decisions.

Power distance: This refers to a cultural continuum that signifies the level of equality between members within a society [19]. In countries with high power distance, individuals exhibit different levels of power based on their social position and status within the community. Members with less power unconditionally perpetuate inequalities by being submissive and showing respect for members with higher levels of power.

In high power distance cultures, it is against expected social conduct for individuals with lower social status to freely and objectively express opinions that are opposite to those of higher status members. These conflicting behaviours are perceived as unethical and immoral conduct. Therefore, informational openness and the free exchange of ideas are generally discouraged in a high power distance culture [49]. Those societies "would be prone to the manipulative use of power for the pursuit of personal benefits", rather than for the overall group advantage, which challenges their status quo [50,51]. Based on these studies, it is expected that CEOs from high power distance cultures will focus on economic and financial interests that can enhance their corporation's power and incentives, rather than working toward a 'green' corporation. In other words, lower power distance is associated with a 'greener' culture.

Uncertainty Avoidance: Hofstede [19] refers to the uncertainty avoidance dimension as the level of threat or discomfort that individuals feel toward uncertainty and ambiguity. Individuals from a weak uncertainty avoidance culture tend to be more ready to face and deal with uncertainty, and hence they are more tolerant of risk, and vice versa [52]. Applying this concept to environmental issues, global warming, natural resource depletion, and other ongoing matters with nature are less of a concern to individuals with low uncertainty avoidance. As a result, fewer pro-environmental behaviours and actions are taken by this cultural group. Consequently, we expect that CEOs with higher uncertainty avoidance values tend to adopt more pro-environmental corporate strategies and decisions, leading to better environmental performance of firms and lower GHG emissions.

Long-term orientation: Societies with different values for time orientation deal with the challenges of the present and future differently. Those that place greater focus on the future exhibit a high long-term orientation index, and vice versa [19]. Trotman and Bradley [53] found that managers with long-term horizons are likely to disclose more social responsibility information. Apparently, 'green' behaviours and pro-environmental strategies are actions for the future, and hence are more likely to be taken by individuals with long-term vision. Luo and Tang [18] suggested that stakeholders and managers from cultures with high long-term orientation values would invest more in green production and clean energy projects and focus more on climate stabilisation. Accordingly, individuals exhibiting long-term orientation tend to be 'greener' individuals. We therefore predict that CEOs with longer future-oriented natures are more likely to adopt 'green' policies and hence mitigate the GHG emissions of firms.

Indulgence versus restraint: This cultural continuum is the newest dimension of Hofstede et al. [54] and it has received much less focus in academic research despite its relevance. This cultural continuum refers to the extent to which individuals can control their impulses and desires related to life enjoyment. Individuals affected by higher indulgence values tend to exhibit weak control of their desires and place greater emphasis on enjoying life and having fun. On the other hand, individuals with a restrained cultural nature can better "control gratification of need and regulate it by means of strict social norms" [55] (p. 11). Therefore, it can be argued that indulgent individuals focus heavily on 'non-lasting' happiness. On the other hand, restrained individuals exhibit better perceptions

and are better able to maintain appropriate and moral discipline in society. Based on this understanding, it can be inferred that CEOs with a high indulgence index will focus more on enjoying their lives through more generous compensation packages, greater power and control over firms, and by providing other privileges. Therefore, they may be motivated to successfully achieve the firm's financial goals and tend to forgo or undervalue other non-financial corporate outcomes, including environmental performance. Consequently, higher indulgence is analogous to a 'less green' culture.

Taken all together, it is expected that CEOs with 'green' cultures will exhibit higher individualism, uncertainty avoidance, and long-term orientation, and lower power distance, masculinity, and indulgence. CEOs with those cultural values and backgrounds are expected to place greater focus on non-financial environmental corporate aspects. Consequently, they are more likely to make strategic decisions that direct firms to achieve 'greener' images and reputations. Specifically, we propose a hypothesis that firms run by CEOs with 'greener' cultural values are more likely to obtain better environmental performance with lower GHG emissions.

H2. *Firms led by CEOs from countries with greener cultural values exhibit significantly lower GHG emissions.*

3. Data Sample and Methodology

3.1. Data

To examine the effects of two novel characteristics of the foremost executive firm managers on corporate climate change performance, we used a sample consisting of all firms listed on the FTSE250 index from 2008 to 2018. We chose this period to avoid the potential effects of global crises, e.g., the global financial crisis of 2008 and COVID-19, which may have influenced the validity of our results. FTSE250 firms are considered to be the second largest firms in the UK. These firms have experienced an increase in female representation on the board, reaching 23.1% in 2015; this is expected to increase to 36.3% in 2020 [56]. According to a UK government report, female representation on the board increased by roughly 40% from 2011 to 2013 to reach 13.2% of the boards of directors of FTSE250 firms. In addition, firm-specific financial, environmental, and corporate governance data were gathered from Bloomberg. Given the availability of the dataset, our final sample consisted of 1496 firm-year observations.

3.2. Dependent Variable: Greenhous Gas (GHG) Emissions

The dependent variable, GHG_EMISS, was measured using the natural logarithm of the ratio of total metric tonnes of GHGs emitted per millions of earnings before interest and tax (EBIT). GHG_EMISS reflects both total GHG and CO_2 emissions, which are an indicator of carbon performance [57]. This measure is consistent with previous literature measurements for carbon performance [58–60]. Furthermore, this measure reflects the underlying firm carbon emission consumption and its true position on carbon exposure. We expected firms with better performance to use less GHG_EMISS and thus to be less harmful to the environment. In addition, GHG_EMISS was estimated based on Environmental, Social and Governance (ESG) data, which are available in Bloomberg.

3.3. Independent Variables: CEO Environmental Values and 'Green' Cultural Index (GCI)

Following substantial extant studies, CEO environmental values and GCI was constructed based on their nationality [31,61–65]. Each country was assigned an EPI and values for all six Hofstede cultural dimensions, which ranged from 0 to 100. Regarding the former, EPI covers two fundamental aspects of the environment and sustainability: environmental health and ecosystem vitality [39]. According to Hershfield et al. [31], individuals from countries with higher EPIs tend to exhibit greater concerns, attitudes, efforts, and behaviours toward environment-related matters.

To measure CEO green cultural index (GCI), an average score of all six Hofstede cultural dimensions for each country was calculated, as shown in Equation (1):

$$GCI_i = \frac{IDV + UAI + LTO + (100 - PDI) + (100 - MAS) + (100 - IVR)}{6} \quad (1)$$

where GCI_i is the green cultural index of country i, IDV denotes the individualism index, UAI denotes the uncertainty avoidance index, LTO denotes the long-term orientation index, PDI denotes the power distance index, MAS denotes the masculinity index, and IVR denotes the indulgence index. For the last three cultural continuums, the values were reverted, as lower values of PDI, MAS, and IVR indicate a greener culture.

The use of a single cultural index carries two main advantages. First, Hofstede [19] emphasised the high level of correlation between his cultural dimensions. According to Table 1, the correlation matrix for the six cultural dimensions was statistically significant at the 1% critical level. Particularly, significantly high correlations were captured for IVR-PDI (r = 83%), IVR-UAI (r = 76%), and UAI-PDI (r = 75%). Therefore, the inclusion of all six cultural variables in the same model specification potentially resulted in a multicollinearity issue [66]. Second, the CEO was assigned a set of cultural values based on his/her original country, rather than a random mixture of cultural beliefs. For example, a British CEO exhibits cultural values of PDI-35, IDV-89, MAS-66, UAI-35, LTO-51, and IVR-69. Consequently, it can be understood that these cultural values may jointly contribute to the 'green' attitudes and behaviours of CEOs. It is also possible that the 'green' aspects of these cultural values may be insignificant when accounted for separately, but that they mutually interact and strengthen one other. This can be seen through the correlations between them—some had negative relationships and others were positive. In other words, we looked at the CEO overall green culture rather than focusing on the 'influence-or-no-influence' matter of each cultural dimension. The dependent, independent, and control variables are presented in Table 1.

Table 1. Definitions and Measurements of Study Variables.

Variable	Definition	Measurement
Dependents variables		
GHG_EMISS	Total greenhouse gas emissions per earning	Natural logarithm of the ratio of total metric tonnes of greenhouse gases emitted per million to earnings before interest and tax (EBIT)
GHG_EMISS_SALES	Total greenhouse gas emissions per sale	Natural logarithm of the ratio of total metric tonnes of greenhouse gases emitted per million to sales
SCOPE1	Direct greenhouse gas emissions per sale	Natural logarithm of the ratio of total metric tonnes of direct greenhouse gases emitted per million to sales
SCOPE2	Greenhouse gas emissions per sale from directly purchased energy	Natural logarithm of the ratio of total metric tonnes of directly purchased greenhouse gases emitted per million to sales
SCOPE3	Indirect greenhouse gas emissions per sale	Natural logarithm of the ratio of total metric tonnes of indirect greenhouse gases emitted per million to sales
Independents variables		
CEO_EPI	CEO environmental values	Proxied by the Environmental Performance Index of the CEO's country of nationality
CEO_GCI	CEO green cultural index	Proxied by the six cultural dimensions of Hofstede (2001) [19] assigned to the CEO's country of nationality

Table 1. *Cont.*

Variable	Definition	Measurement
Control variables		
CEO_Age	CEO age	The CEO's biological age
CEO_Duality	CEO duality	Dummy variable that takes the value of 1 if the CEO also holds the chairman role or 0 otherwise
CEO_Tenure	CEO tenure	The number of years since the CEO has been appointed to the role
BOD_Size	Board Size	The number of individuals in the board of directors
BOD_IND	Independent Directors	The percentage of independent directors in the board of directors
SIZE	Firm Size	Natural logarithm of market value
CAPEX	Capital expenditure	Measured by total capital expenditure divided by earnings before interest and tax (EBIT)
LEV	Financial leverage	Total debt divided by market value
TobinQ	TobinQ	Market value of the replacement cost of the firm's assets
ROA	Return on assets	Total return to total assets
PPE	Property, plant and equipment	The ratio of net property, plant, and equipment to gross property, plant, and equipment
FEXCH_SALES	Foreign exchange gain/loss	Ratio foreign exchange gain/loss to EBIT

Moreover, the correlation between the six Hofstede's cultural dimensions discussed above is presented in Table 2.

Table 2. Correlation matrix. This table presents the correlations between the six Hofstede's cultural dimensions. IDV-Individualism; PDI-Power distance; UAI-Uncertainty avoidance; MAS-Masculinity; LTO-Long-term orientation; and IVR-Indulgence.

	IDV	PDI	UAI	MAS	LTO	IVR
IDV	1					
PDI	−0.67	1				
UAI	−0.64	0.75	1			
MAS	0.49	−0.36	−0.35	1		
LTO	−0.12	0.16	0.06	−0.08	1	
IVR	0.70	−0.83	−0.76	0.19	−0.24	1

3.4. Model Specification

We estimated the associations between CEO environmental and green cultural values and firm GHG emissions using the following baseline OLS robust standard error estimation model represented in Equation (2):

$$\begin{aligned} GHG\_intensity = {} & \beta_0 + \beta_1 CEO\_EPI + \beta_2 CEO\_GCI + \beta_3 CEO\_Age + \beta_4 CEO\_Duality + \beta_5 CEO\_Tenure + \\ & \beta_6 BODSIZE + \beta_7 BOD\_IND + \beta_8 SIZE + \beta_9 CAPEX + \beta_{10} LEV + \beta_{11} TobinQ + \beta_{12} ROA + \beta_{13} PPE + \\ & \beta_{14} FEXCH\_SALES + Year.FE + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where $GHG\_Intensity_{i,t}$ is the measure of total GHG performance of firm i at time t; and $CEO\_EPI_{i,t}$ and $CEO\_GCI_{i,t}$ are the environmental and green cultural values of CEOs of firm i at time t, respectively. To distinguish the effect of the CEO's environmental and cultural values on the firm's GHG emissions, we further accounted for a number of control variables.

For our control variables, we included CEO age (CEO_Age); CEO duality (CEO_Duality); CEO tenure (CEO_Tenure); board size (Board_Size); percentage of independent directors

(IND_D); firm size (SIZE); capital expenditure (CAPEX); financial leverage (LEV); TobinQ (TobinQ); return on assets (ROA); property, plant, and equipment (PPE); and foreign exchange gain/loss (FEXCH_SALES).

We included many control variables that related to the CEO's characteristics and the firm's corporate governance. The CEO's characteristic variables included CEO age (CEO_Age), CEO duality (CEO_Duality), and CEO tenure (CEO_Tenure). We also controlled for board size (Board_Size) and the percentage of independent directors (IND_D). We expected larger board size to result in better environmental performance [13,67]. That is, a greater number of members of the board of directors was expected to include more experts on environmental issues in an attempt to reduce the uncertainty surrounding these issues. Higher IND_D should motivate firm managers to report carbon information and consider its importance for investors in evaluating firm risk and investment decisions. We controlled for many variables that related to firm characteristics. We included firm size in the regression, as firms that are larger in size are more likely to absorb environment costs than smaller sized firms [68]. Firms that have higher spending on capital tend to be more inclined to invest in environmental matters and hence they have better environmental performance [57,60]. Financial leverage is significantly linked with a firm's decision to make environmental investments or to develop an environmental strategy [58]. Thus, we expected LEV to have a positive association with GHG_Intensity. We also controlled for firm financial performance measured by ROA. Financial performance is positively associated with environmental performance [57]. We controlled for TobinQ to reflect innovation capability and investment opportunity [60]. In addition, we controlled for property, plant, and equipment because firms that have new equipment tend to have less polluting and more environmentally friendly technology, which should lead to better environmental performance [58]. Firms that have higher foreign sales are expected to face greater pressure from environmental groups and thus they were expected to have better environmental performance [69].

Furthermore, CEO_Age measured the biological age of CEOs. CEO duality (CEO_Duality) was a dummy variable that took the value of 1 if the CEO also held the role of chairman, or 0 otherwise. CEO tenure (CEO_Tenure) was measured by the number of years the CEO had been appointed in the role. BODSIZE reflected the number of individuals on the board of directors. BOD_IND reflected the percentage of independent of directors on the board of directors. Firm size equaled the natural logarithm of market value. Capital expenditure (CAPEX) was measured by total capital expenditure divided by earnings before interest and tax (EBIT). Financial leverage (LEV) was estimated as the total debt divided by market value. TobinQ was the market value of the replacement cost of the firm's assets. Return on assets (ROA) was computed as the ratio of total returns to total assets. PPE was the ratio of net to gross property, plant, and equipment. We also controlled for foreign exchange gain/loss (FEXCH_SALES), which was estimated using the ratio of foreign exchange gain/loss to EBIT.

4. Results

4.1. Descriptive Statistics and Corolations

Table 3 presents the descriptive statistics of all of the variables used in the main estimation model presented in Equation (2). The mean value of GHG_EMISSION was 5.99; it was higher for highly carbon-intensive industries (M = 6.5) compared to low carbon-intensive industries (M = 5.2) at a 1% critical level. Table 3 further shows that the average CEO_EPI was 76.4, which was above the middle point of the scale. This can be explained by the fact that most CEOs in the FTSE250 were from developed countries with high EPIs. On the other hand, the average green cultural index (CEO_GCI) was around 53. Different from the EPI, the CEO's cognition and attitudes toward environmental issues are implicitly (rather than explicitly) derived from the cultural dimensions of Hofstede [19], as described in Equation (1). The average age of CEOs in our sample was around 52 years old. On average, CEOs had been in this role for around 6 years and only 2% of CEOs were also

assigned the role of chairman. The board of directors contained 9 directors on average, of which 5 directors were independent (≈60%).

Table 3. Descriptive statistics. This table reports the descriptive statistics of all variables used in our empirical model. GHG_Intensity is the total greenhouse gas emissions per earnings before interest and tax (Equation (2)). CEO_EPI is the environmental values of the CEO measured by the Environmental Performance Index (EPI) of the CEO's country of nationality. CEO_GCI is the CEO's green cultural index measured by the average of the six cultural dimensions of the CEO's country of nationality. CEO_Age is the biological age of the CEO. CEO_Duality denotes unity if the firm's CEO is also appointed as the chairman of the board of directors and zero otherwise. CEO_Tenure is the number of years since the CEO has been appointed to the role. BODSize is the average number of members in the board of directors. BOD_IND is the percentage of independent directors in the board of directors. Firm size is the firm's market capitalisation value. CAPEX is measured by the total capital expenditures divided by EBIT. Leverage is the ratio of total debt to market value. Tobin Q is the market value of the replacement cost of the firm's assets. ROA is the return to assets ratio. PPE is the ratio of net property, plant, and equipment to gross property, plant, and equipment. FEXCH_Sales is the ratio of foreign exchange gain/loss to EBIT.

Variable	N	Mean	SD	p50	Min	Max
Dependent variables						
GHG_EMISS	1506	5.99	2.16	6.09	0	12.61
CEO culture characteristics						
CEO_EPI	2870	76.40	11.95	79.89	30.57	87.42
CEO_GCI	2889	53.12	9.42	50.79	38.67	100.00
Governance variables						
CEO_AGE	2828	52.38	6.00	52.00	34.00	77.00
CEO_DUALITY	2700	0.02	0.12	0.00	0.00	1.00
CEO_TENURE	2484	6.92	40.63	4.67	0.08	2011.92
BODSIZE	2700	9.33	2.35	9.00	4.00	21.00
BOD_IND	2687	60.24	12.59	60.00	0.00	100.00
Firm-specific variables						
SIZE	2889	7.55	1.33	7.49	2.25	11.94
CAPEX	2553	−0.57	3.58	−0.30	−119.80	62.50
LEV	2757	3.57	1.71	3.95	0.00	6.38
TOBINQ	2761	1.95	3.29	1.43	0.47	80.94
ROA	2802	7.03	13.81	5.53	−53.54	236.78
PPE	2889	0.53	0.24	0.50	0.05	9.46
FEXCH_SALES	2889	0.00	0.28	0.00	−7.04	9.88

Table 4 presents the bivariate correlations between our independent variables to detect potential multicollinearity issues. First, CEO environmental values were significantly and positively associated with CEO GCI (r = 0.2, $p < 0.01$). This indicated that CEOs from greener cultures tend to exhibit higher environmental values. The strength of the correlation was relatively weak, as they are two different environment-related personal aspects of CEOs derived from different perspectives. Therefore, it was essential to examine these two constructs separately. Overall, we did not detect any potential multicollinearity issue because the correlations between the independent variables were weak (r < 0.4). Furthermore, the correlation results presented in Table 4 also indicated the significant and negative influences of CEO_EPI and CEO_GCI on firm GHG emissions (r = −0.16, −0.18; $p < 0.01$, respectively). This preliminary test supported our two hypotheses that firms run by CEOs from high-EPI countries and greener cultures tend to produce less carbon emissions. Nevertheless, in order to draw a conclusion, more comprehensive analyses were conducted and discussed in the following sections.

Table 4. Correlation matrix. This table reports the correlation matrix among independent variables used in our empirical models. **Bold** figures denote a significance level of 10% or below.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1. GHG_EMISS	1													
2. CEO_EPI	**−0.16**	1												
3. CEO_GCI	**−0.18**	**0.2**	1											
4. CEO_Age	−0.02	**−0.2**	0.02	1										
5. CEO_Duality	−0.003	**−0.05**	0.016	**0.13**	1									
6. CEO_Tenure	−0.002	**−0.1**	**−0.06**	**0.3**	**0.13**	1								
7. Board_Size	0.01	0.003	**0.12**	**0.14**	0.02	**−0.07**	1							
8. BOD_IND	0.04	**−0.15**	**0.1**	**0.21**	−0.02	**−0.15**	**0.11**	1						
9. SIZE	**0.09**	**−0.16**	0.03	**0.13**	0.03	**−0.07**	**0.36**	**0.3**	1					
10. CAPEX	**−0.07**	0.03	0.01	0.04	−0.01	**0.08**	−0.04	**−0.05**	**−0.05**	1				
11. LEV	**0.07**	0.002	0.005	**0.05**	**−0.07**	**−0.12**	**0.18**	**0.1**	**0.12**	−0.04	1			
12. TobinQ	**−0.11**	0.003	0.03	**−0.12**	0.03	0.06	**−0.1**	−0.03	−0.001	**0.07**	**−0.22**	1		
13. ROA	**−0.12**	−0.01	0.02	**−0.1**	0.02	0.03	**−0.09**	−0.03	−0.04	0.03	**−0.26**	**0.6**	1	
14. PPE	**0.13**	**−0.07**	0.02	0.01	0.00	**0.08**	**0.06**	−0.01	0.01	−0.05	**0.13**	**−0.13**	−0.03	1
15. FEXCH_SALES	0.04	−0.04	−0.03	0.04	0.01	0.02	−0.02	0.03	0.01	**−0.1**	0.04	−0.005	**0.07**	−0.02

4.2. Regression Results and Discussion

Effects of CEO Environmental Values and Green Cultural Index on GHG Emissions

The results of our main robust OLS regression (Equation (2)) are presented in Table 5 with three model specifications. Model 1 (column 1) contained only the two key independent variables, i.e., CEO_EPI and CEO_GCI, and the year fixed effect. The second specification (column 2) extended model 1 by further controlling for a number of governance factors. These were CEO tenure, CEO age, CEO duality, board size (BODSIZE), and the proportion of independent board directors (BOD_IND).

Table 5. Effects of CEO environmental and green cultural values on firm greenhouse gas emissions. This table reports OLS regression results on the association between CEO environmental and green cultural values and firm greenhouse gas emissions. The dependent variable is measured by the level of greenhouse emissions per earnings (GHG_EMISS). Our main independent variables are CEO_EPI, the environmental values of the CEO measured by the Environmental Performance Index (EPI) of the CEO's country of nationality, and CEO_GCI, the CEO's green cultural index measured by the average of the six cultural dimensions of the CEO's country of nationality. Control variables include CEO_Age, the biological age of the CEO. CEO_Duality denotes unity if the firm's CEO is also appointed as the chairman of the board of directors and zero otherwise. CEO_Tenure is the number of years since the CEO has been appointed to the role. BODSize is the average number of members in the board of directors. BOD_IND is the percentage of independent directors in the board of directors. Firm size is the firm's market capitalisation value. CAPEX is measured by the total capital expenditures divided by EBIT. Leverage is the ratio of total debt to market value. Tobin Q is the market value of the replacement cost of the firm's assets. ROA is the return to assets ratio. PPE is the ratio of net property, plant, and equipment to gross property, plant, and equipment. FEXCH_SALES is the ratio of foreign exchange gain/loss to EBIT. Robust standard errors are given in parentheses. **Bold** figures denote a significance level of 10% or below.

Variables	(1) GHG_EMISS	(2) GHG_EMISS	(3) GHG_EMISS
CEO_EPI	**−0.0307**	**−0.0283**	**−0.0315**
	(0.00933)	(0.00940)	(0.00911)
CEO_GCI	**−0.0436**	**−0.0433**	**−0.0486**
	(0.0152)	(0.0152)	(0.0139)
CEO_TENURE		0.0115	0.0177
		(0.0137)	(0.0131)
CEO_AGE		**−0.0284**	**−0.0426**
		(0.0117)	(0.0122)
CEO_DUALITY		0.259	0.230
		(0.588)	(0.615)

Table 5. *Cont.*

Variables	(1) GHG_EMISS	(2) GHG_EMISS	(3) GHG_EMISS
BODSIZE		0.0174	−0.0495
		(0.0289)	(0.0363)
BOD_IND		0.00285	−0.00237
		(0.00532)	(0.00562)
CAPEX			−0.0314
			(0.0232)
SIZE			**0.140**
			(0.0524)
ROA			**−0.0222**
			(0.0111)
LEV			0.0469
			(0.0410)
TOBINQ			−0.123
			(0.0942)
PPE			**1.624**
			(0.339)
FEXCH_SALES			**0.782**
			(0.386)
Constant	**10.69**	**11.32**	**11.69**
	(1.432)	(1.561)	(1.542)
YEAR EFFECTS	YES	YES	YES
Observations	1496	1279	1184
R-squared	0.026	0.034	0.092

Our results revealed the negative association between CEO environmental values and GHG emissions for all model specifications ($\beta_{CEO\_EPI} = -0.03$, $p < 0.01$, columns 1–3). Specifically, the findings indicated that firms run by CEOs from countries with higher environmental health and ecosystem vitality, together with better performance in addressing environmental challenges, tend to produce fewer GHG emissions from their operations. This may be drawn from the CEO's cognition and environmentally friendly attitudes inherited from their homeland. According to this main finding, hypothesis 1 was supported.

Less explicit than CEO environmental values, CEO green cultural values reflect an individual's entrenched environment-related concerns and cognition based on the six cultural backgrounds defined by Hofstede [19]. Based on the obtained results, we found that CEOs with higher green cultural values tend to make more pro-environmental strategic decisions for firms, leading to lower GHG emissions. This finding was shown through the consistent negative coefficients of the CEO green cultural index (CEO_GCI) across all of the estimation models ($\beta_{CEO\_GCI} = -0.044$, -0.043, and -0.049; $p < 0.01$; columns 1–3, respectively). Consequently, hypothesis 2 was supported.

Overall, our main findings indicated the significant influence of CEO environmental and green cultural values on GHG emissions. Particularly, CEOs from countries with a higher Environmental Performance Index (EPI) and higher overall green cultural values (GCI) tend to direct firms toward a 'greener' image and reputation through lower climate change exposure.

In addition, variables such as CEO_Age, SIZE, ROA, FEXCH_SALES, and PPE exerted significant effects on the total GHG emissions per earning of firms. As can be seen, CEO_Age was negatively associated with GHG_EMISS, suggesting that older CEOs make greener corporate decisions, hence mitigating the carbon emission production of firms. This finding was supported by a study by Glass et al. [10], which reported a significant positive relationship between the average age of board members and environmental strength. Konisky, Milyo and Richardson [70] (p. 1078) also found that older adults have more favorable attitudes toward government environmental policies addressing both local- and national-scale issues, compared with their younger counterparts. Furthermore, firm size

positively and significantly influenced firm GHG performance at the 1% critical level, which was consistent with the studies of Haque [56] and Haque and Ntim [71]. Firm profitability showed a negative relationship with GHG emissions, implying that firms with better financial performance tend to be 'greener' firms. The authors stated that larger firms are required to maintain their economic scale for their overall operations, which leads to greater GHG emissions. Nevertheless, this can be moderated by firms employing advanced technologies for energy efficiency. Qiu, Shaukat and Tharyan [72] suggested that profitable firms benefit from greater economic resources and are thus able to adopt more proactive strategies to address environmental concerns. Lastly, a higher proportion of foreign exchange revenue was shown to increase the level of GHG emissions. This may be driven by the need to maintain high production levels in order to meet foreign demand, leading to high production of GHG emissions.

Misani and Pogutz [73] suggested the importance of the reduction in GHG emissions for carbon-intensive industries. Therefore, it was relevant to examine the effects that CEO environmental and cultural values on GHG emissions in these industries. Consequently, we tested our main OLS estimation model (Equation (2)) on high and low carbon-intensive samples. The results for the two samples are presented in Table 6, Panels A and B, respectively. The results for both samples across all model specifications indicated that the negative influence of the CEO's environmental values on the firm's GHG emissions was consistent across both high and low carbon-intensive industries. Furthermore, a marginal influence was shown to be stronger for low carbon-intensive industries than for their highly carbon-intensive counterparts ($\beta_{CEO\_EPI(1–3)} \approx -0.02$; $\beta_{CEO\_EPI(4–6)} \approx -0.04$, $p \leq 0.01$). Nevertheless, CEO GCI was only negatively associated with GHG emissions for low carbon-intensive industries ($\beta_{CEO\_GCI(4–6)} \approx -0.01$, $p \leq 0.01$), whilst no significant influence was obtained for the high carbon-emission sample ($\beta_{CEO\_GCI(1–3)} \approx -0.01$, n.s). These findings implied that highly carbon-intensive firms can reduce their carbon emission levels by appointing CEOs from countries with better pro-environmental practices, but not through their cultural backgrounds. This may be because a country is assigned a higher EPI when its environmentally friendly practices are more explicitly and publicly promoted through the media, regulations, rules, and policies [39]. Consequently, individuals living in those high-EPI nations are more directly exposed to and inherit such pro-environmental practices. On the other hand, the cultural backgrounds defined by Hofstede [19] implicitly rather than explicitly imply and relate to an individual's environmental concerns and attitudes. Consequently, the effect of cultural index on GHG emission levels was less pronounced than that of environmental values. In other words, CEOs from high-EPI countries are expected to have higher and more direct incentives and concerns regarding pro-environmental actions compared to CEOs from 'greener' cultural backgrounds. Applying this to high and low carbon-intensive contexts, due to the nature of highly carbon-intensive firm operations, it is more challenging to reduce GHG emissions in the current industrialised era because "most conventional energy systems have been based on fossil fuel consumption" [74] (p. 197). Therefore, in order to effectively bring down the GHG emissions of highly carbon-intensive firms, the environmentally friendly attitudes and motivations of CEOs should reach the critical mass, and the CEO's cultural background may not be able to sufficiently drive such attitudes and concerns, in contrast to environmental values. As a result, only the effect of the CEO's environmental values is significant in reducing the GHG emissions in highly carbon-intensive firms.

Furthermore, since the operations and nature of financial and non-financial firms are distinct at different levels and in different aspects, we re-examined the influences of CEO environmental and cultural values on firm GHG emissions in a non-financial sample [2,13,56,75]. Using the same OLS robust estimation models as was used for the main findings, the results presented in Table 7 revealed the significant and negative associations between CEO environmental-cultural values and firm GHG emissions. The findings were once again consistent across different model variations (Table 5, columns 1–3).

Table 6. Effects of CEO environmental and green cultural values on firm greenhouse gas emissions for high and low carbon-intensive industries. This table reports OLS regression results on the association between CEO environmental and green cultural values and firm greenhouse gas emissions for highly carbon-intensive industries (Panel A) and low carbon-intensive industries (Panel B). Highly carbon-intensive industries comprise firms operating in materials, energy, oil and gas, industry, and utilities. Other industries in the sample are classified as low carbon-intensive industries. The dependent variable is measured by the level of greenhouse emissions per earnings (GHG_EMISS). Our main independent variables are CEO_EPI, the environmental values of the CEO measured by the Environmental Performance Index (EPI) of the CEO's country of nationality, and CEO_GCI, the CEO's green cultural index measured by the average of the six cultural dimensions of the CEO's country of nationality. Control variables include CEO_Age, the biological age of the CEO. CEO_Duality denotes unity if the firm's CEO is also appointed as the chairman of board of directors and zero otherwise. CEO_Tenure is the number of years since the CEO has been appointed to the role. BODSize is the average number of members in the board of directors. BOD_IND is the percentage of independent directors in the board of directors. Firm size is the firm's market capitalisation value. CAPEX is measured by the total capital expenditures divided by EBIT. Leverage is the ratio of total debt to market value. Tobin Q is the market value of the replacement cost of the firm's assets. ROA is the return to assets ratio. PPE is the ratio of net property, plant, and equipment to gross property, plant, and equipment. FEXCH_SALES is the ratio of foreign exchange gain/loss to EBIT. Robust standard errors are given in parentheses. **Bold** figures denote a significance level of 10% or below.

	Panel A: Highly Carbon-Intensive Industries			**Panel B: Low Carbon-Intensive Industries**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variables	**GHG_EMISS**	**GHG_EMISS**	**GHG_EMISS**	**GHG_EMISS**	**GHG_EMISS**	**GHG_EMISS**
CEO_EPI	**−0.0257**	**−0.0277**	**−0.0225**	**−0.0459**	**−0.0366**	**−0.0346**
	(0.00978)	(0.0101)	(0.00923)	(0.0141)	(0.0136)	(0.0132)
CEO_GCI	−0.0116	−0.0139	−0.0181	**−0.114**	**−0.120**	**−0.115**
	(0.0153)	(0.0149)	(0.0135)	(0.0225)	(0.0225)	(0.0223)
CEO_AGE		−0.0189	**−0.0422**		**−0.0344**	−0.0398
		(0.0137)	(0.0140)		(0.0207)	(0.0249)
CEO_DUALITY		−0.0686	0.104		0.361	0.0853
		(0.514)	(0.515)		(1.318)	(1.274)
CEO_TENURE		**0.0307**	**0.0369**		−0.0128	−0.0132
		(0.0133)	(0.0129)		(0.0234)	(0.0230)
BODSIZE		0.0299	−0.0239		**0.120**	0.0505
		(0.0362)	(0.0418)		(0.0423)	(0.0629)
BOD_IND		0.00300	−0.00589		−0.00370	−0.0119
		(0.00640)	(0.00677)		(0.00832)	(0.00897)
SIZE			**0.113**			**0.216**
			(0.0607)			(0.0850)
CAPEX			**−0.0701**			0.0107
			(0.0296)			(0.0129)
LEV			**−0.0971**			0.0280
			(0.0440)			(0.0709)
TobinQ			**−0.484**			0.0794
			(0.107)			(0.149)
ROA			0.00378			−0.0274
			(0.0109)			(0.0216)
PPE			**0.676**			1.528
			(0.209)			(0.952)
FEXCH_SALES			0.386			1.999
			(0.375)			(1.383)
Constant	**8.806**	**9.216**	**10.96**	**15.32**	**15.56**	**14.25**
	(1.497)	(1.817)	(1.716)	(2.208)	(2.276)	(2.560)
YEAR EFFECTS	YES	YES	YES	YES	YES	YES
Observations	955	828	794	541	451	390
R-squared	0.059	0.073	0.146	0.113	0.140	0.175

Table 7. Effects of CEO environmental and green cultural values on firm greenhouse gas emissions for a non-financial sample. This table reports regression results on the association between CEO environmental and green cultural values and firm greenhouse gas emissions for non-financial firms. The dependent variable is measured by the level of greenhouse emissions per earnings (GHG_EMISS). Our main independent variables are CEO_EPI, the environmental values of the CEO measured by the Environmental Performance Index (EPI) of the CEO's country of nationality, and CEO_GCI, the CEO's green cultural index measured by the average of the six cultural dimensions of the CEO's country of nationality. Control variables include CEO_Age, the biological age of the CEO. CEO_Duality denotes unity if the firm's CEO is also appointed as the chairman of board of directors and zero otherwise. CEO_Tenure is the number of years since the CEO has been appointed to the role. BODSize is the average number of members in the board of directors. BOD_IND is the percentage of independent directors in the board of directors. Firm size is the firm's market capitalisation value. CAPEX is measured by the total capital expenditures divided by EBIT. Leverage is the ratio of total debt to market value. Tobin Q is the market value of the replacement cost of the firm's assets. ROA is the return to assets ratio. PPE is the ratio of net property, plant, and equipment to gross property, plant, and equipment. FEXCH_SALES is the ratio of foreign exchange gain/loss to EBIT. Robust standard errors are given in parentheses. **Bold** figures denote a significance level of 10% or below.

Variables	**(1)** **GHG_EMISS**	**(2)** **GHG_EMISS**	**(3)** **GHG_EMISS**
CEO_EPI	**−0.0220**	**−0.0226**	**−0.0228**
	(0.00915)	(0.00943)	(0.00904)
CEO_GCI	**−0.0267**	**−0.0293**	**−0.0364**
	(0.0142)	(0.0143)	(0.0133)
CEO_TENURE		**0.0279**	**0.0304**
		(0.0123)	(0.0122)
CEO_AGE		**−0.0283**	**−0.0405**
		(0.0122)	(0.0122)
CEO_DUALITY		−0.0435	−0.0148
		(0.579)	(0.577)
BODSIZE		0.0103	−0.0305
		(0.0317)	(0.0366)
BOD_IND		0.00252	−0.00163
		(0.00533)	(0.00553)
CAPEX			**−0.0810**
			(0.0315)
SIZE			0.0715
			(0.0543)
ROA			−0.00990
			(0.0112)
LEV			−0.0236
			(0.0418)
TOBINQ			**−0.272**
			(0.111)
PPE			0.955
			(0.210)
FEXCH_SALES			**0.664**
			(0.372)
Constant	**9.312**	**10.34**	**11.40**
	(1.357)	(1.530)	(1.486)
YEAR EFFECTS	YES	YES	YES
Observations	1230	1063	1028
R-squared	0.034	0.045	0.095

4.3. Robustness Checks

Following de Villiers et al. [67], we re-tested our model in Equation (2) to account for endogeneity problems by employing three methods: the lagged approach, 2-stage least square (2SLS), and the two-step Generalised Method of Moment (GMM) of Wintoki, Linck and Netter [76]. With the use of these methods, especially GMM, all types of endogeneity issues were controlled for, including reverse causality, regressor measurement errors, and omitted variables. The results of these analyses are presented in Table 8, which revealed that the negative influences of CEO environmental and cultural values on GHG emissions remained statistically significant across all approaches at the 1% critical level. We also confirmed the validity of GMM estimators (Table 8, column 3) through the statistically significant first-order correlation AR(1) (p-value < 5%). Furthermore, we also reported the second-order correlation AR(2) and over-identification Hansen test results. Both tests revealed insignificant statistical results (p-value > 0.05). Therefore, no serial correlation of second differences were confirmed and our employed instruments were proven to be valid. Overall, after controlling for different potential endogeneity problems, we could still conclude that firms operating under the leadership of CEOs who are from countries with strong environmental practices and 'greener' cultures tend to produce lower GHG emissions.

Table 8. Robustness check: Lag approach, 2-stage least square (2SLS), and generalised method of moment (GMM) to test the effects of CEO environmental and green cultural values on firm greenhouse gas emissions. The dependent variable is measured by the level of greenhouse emission per earnings (GHG_EMISS). Our main independent variables are CEO_EPI, the environmental values of the CEO measured by the Environmental Performance Index (EPI) of the CEO's country of nationality, and CEO_GCI, the CEO's green cultural index measured by the average of the six cultural dimensions of the CEO's country of nationality. Control variables include CEO_Age, the biological age of the CEO. CEO_Duality denotes unity if the firm's CEO is also appointed as the chairman of the board of directors and zero otherwise. CEO_Tenure is the number of years since the CEO has been appointed to the role. BODSize is the average number of members in the board of directors. BOD_IND is the percentage of independent directors in the board of directors. Firm size is the firm's market capitalisation value. CAPEX is measured by the total capital expenditures divided by EBIT. Leverage is the ratio of total debt to market value. Tobin Q is the market value of the replacement cost of the firm's assets. ROA is the return to assets ratio. PPE is the ratio of net property, plant, and equipment to gross property, plant, and equipment. FEXCH_SALES is the ratio of foreign exchange gain/loss to EBIT. Robust standard errors are given in parentheses. **Bold** figures denote a significance level of 10% or below.

	(1)	(2)	(3)
Variables	**Lag**	**2SLS**	**GMM**
L. GHG_EMISS			**0.974**
			(0.0313)
L.CEO_EPI	**−0.0331**		
	(0.00990)		
L. CEO_GCI	**−0.0560**		
	(0.0152)		
CEO_EPI		**−0.0625**	**−0.0302**
		(0.0216)	(0.0147)
CEO_GCI		**−0.0793**	**−0.0597**
		(0.0245)	(0.0215)
CEO_AGE	**−0.0474**	**−0.0517**	−0.0120
	(0.0134)	(0.0137)	(0.0202)

Table 8. *Cont.*

	(1)	(2)	(3)
Variables	**Lag**	**2SLS**	**GMM**
CEO_DUALITY	0.0582	0.115	0.710
	(0.715)	(0.670)	(0.987)
CEO_TENURE	0.0158	0.0192	0.00389
	(0.0141)	(0.0135)	(0.0170)
BODSIZE	−0.0568	−0.0341	0.0136
	(0.0414)	(0.0390)	(0.0429)
BOD_IND	−0.00202	−0.000230	0.00277
	(0.00623)	(0.00597)	(0.00689)
SIZE	**0.162**	**0.123**	−0.0107
	(0.0582)	(0.0553)	(0.0466)
CAPEX	−0.0303	−0.0305	0.0431
	(0.0239)	(0.0240)	(0.0464)
LEV	0.0546	**0.0778**	0.0739
	(0.0459)	(0.0441)	(0.0460)
TobinQ	−0.148	−0.112	−0.0493
	(0.101)	(0.0937)	(0.111)
ROA	−0.0168	**−0.0218**	0.0174
	(0.0125)	(0.0117)	(0.0184)
PPE	**1.647**	**1.573**	0.00347
	(0.368)	(0.306)	(0.317)
FEXCH_SALES	0.534	0.670	**−0.573**
	(0.426)	(0.443)	(0.314)
Constant	**12.21**	**15.38**	**5.617**
	(1.692)	(3.266)	(2.437)
YEAR EFFECTS	YES	YES	YES
Observations	996	1085	821
R-squared	0.103	0.084	
Ar (1) test (*p*-value)			0.02
Ar (2) test (*p*-value)			0.54
Hansen test of over-identification (*p*-value)			0.92
Diff-in-Hansen test of exogeneity (*p*-value)			0.98

Furthermore, we also employed four different measures of the main dependent variables. These alternatives comprised: (1) the amount of total GHG emissions per sale (GHG_emiss_sales); (2) the amount of direct GHG emissions per sale (SCOPE1); (3) the amount of GHG emissions per sale from directly purchased energy (SCOPE2); and (4) the amount of indirect GHG emissions per sale (SCOPE3) [57,77]. It has been documented that most prior studies have paid extensive attention to SCOPE1 and SCOPE2, whilst overlooking SCOPE3. This SCOPE3 (indirect GHG emissions) has been reported to constitute a great proportion (≈75%) of a firm's overall carbon footprint [77–79]. According to the results presented in Table 9, both CEO environmental values (CEO_EPI) and green cultural values (CEO_GCI) held significant and negative associations with firm GHG emissions at a 1% critical level or below. The results were consistent across all alternative measures and with our main GHG measure, indicating that CEOs from high-EPI countries and 'greener' cultures are likely to direct firms toward more environmentally friendly operations.

Table 9. Robustness check: Effects of CEO environmental and green cultural values on firm greenhouse gas emissions using different measures. The alternative dependent variables are (1) the amount of total GHG emissions per sale (GHG_emiss_sales); (2) the amount of direct GHG emissions per sale (SCOPE1); (3) the amount of GHG emissions per sale from directly purchased energy (SCOPE2); and (4) the amount of indirect GHG emissions per sale (SCOPE3). Our main independent variables are CEO_EPI, the environmental values of the CEO measured by the Environmental Performance Index (EPI) of the CEO's country of nationality, and CEO_GCI, the CEO's green cultural index measured by the average of the six cultural dimensions of the CEO's country of nationality. Control variables include CEO_Age, the biological age of the CEO. CEO_Duality denotes unity if the firm's CEO is also appointed as the chairman of board of directors and zero otherwise. CEO_Tenure is the number of years since the CEO has been appointed to the role. BODSize is the average number of members in the board of directors. BOD_IND is the percentage of independent directors in the board of directors. Firm size is the firm's market capitalisation value. CAPEX is measured by the total capital expenditures divided by EBIT. Leverage is the ratio of total debt to market value. Tobin Q is the market value of the replacement cost of the firm's assets. ROA is the return to assets ratio. PPE is the ratio of net property, plant, and equipment to gross property, plant, and equipment. FEXCH_SALES is the ratio of foreign exchange gain/loss to EBIT. Robust standard error are given in parentheses. **Bold** figures denote a significance level of 10% or below.

	(1)	(2)	(3)	(4)
Variables	**GHG_EMISS_Sales**	**SCOPE1**	**SCOPE2**	**SCOPE3**
CEO_EPI	**−0.0276**	**−0.0580**	**−0.0419**	**−0.0652**
	(0.00790)	(0.0100)	(0.00709)	(0.0140)
CEO_GCI	**−0.0457**	**−0.0672**	**−0.0433**	**−0.0814**
	(0.0129)	(0.0166)	(0.0127)	(0.0235)
CEO_AGE	−0.0101	**0.0464**	**0.0283**	−0.0334
	(0.0106)	(0.0125)	(0.00960)	(0.0219)
CEO_DUALITY	0.0779	0.373	−0.163	0.407
	(0.519)	(0.452)	(0.448)	(1.051)
CEO_TENURE	**0.0204**	−0.00823	−0.00220	**0.0512**
	(0.0119)	(0.0124)	(0.0116)	(0.0267)
BODSIZE	−0.0535	**0.158**	**0.145**	**0.396**
	(0.0301)	(0.0419)	(0.0302)	(0.0546)
BOD_IND	−0.00874	**0.0582**	**0.0481**	**0.0878**
	(0.00507)	(0.00708)	(0.00550)	(0.00937)
SIZE	**0.138**	**0.540**	**0.442**	**0.952**
	(0.0466)	(0.0683)	(0.0467)	(0.0941)
CAPEX	−0.0325	**−0.109**	**−0.0631**	**−0.144**
	(0.0276)	(0.0341)	(0.0167)	(0.0290)
LEV	**0.0679**	**0.447**	**0.361**	**0.273**
	(0.0368)	(0.0490)	(0.0389)	(0.0636)
TobinQ	−0.0641	−0.00341	**−0.0872**	−0.0421
	(0.0830)	(0.0331)	(0.0300)	(0.0393)
ROA	−0.0114	−0.0125	0.0115	0.00587
	(0.0105)	(0.00971)	(0.00868)	(0.0119)
PPE	**1.414**	**1.290**	0.594	**3.958**
	(0.296)	(0.692)	(0.384)	(0.688)
FEXCH_SALES	0.453	−0.168	0.367	**−0.597**
	(0.530)	(0.541)	(0.608)	(0.177)
Constant	**7.909**	−1.611	−0.988	**−5.563**
	(1.325)	(1.672)	(1.212)	(2.800)
Year effects	YES	Yes	Yes	Yes
Observations	1286	1374	1373	759
R-squared	0.092	0.356	0.390	0.499

5. Conclusions

This paper examined the effects of CEO environmental values and cultural values on firm GHG emissions. Based on a sample of 1496 firm-year observations from the

FTSE250 covering the period from 2008 to 2018, we obtained two main findings. First, we found that firms operating under the management of CEOs from countries with a high Environmental Performance Index (CEO_EPI) and/or from countries with 'greener' cultural values (CEO_GCI) tend to produce lower GHG emissions. Particularly, high-EPI countries tend to exhibit healthier environmental health and ecosystem vitality. Their pro-environmental practices are publicised and widely promoted within these countries. CEOs from these countries subconsciously inherit those practices to which they are routinely and directly exposed. In a similar manner, 'green' cultural values are entrenched from the six cultural dimensions of Hofstede [19]. CEOs with a higher GCI are expected to place higher value on the non-financial environmental aspects of firms. Intriguingly, we also found that the influence of CEO environmental index on GHG emissions is more pronounced than that of CEO green cultural values. Particularly in highly carbon-intensive industries, CEO GCI does not have a significant impact on GHG emissions. This may be because the influence of the CEO's GCI on their environmental cognition and attitudes is less explicit than that of the CEO's EPI. Currently, there is no specific measure for an environment-related cultural index. Therefore, academic research on this topic tends to employ Hofstede's culture dimensions as proxies.

To assure the robustness of our findings, we performed a number of robustness checks with the use of a non-financial sample, alternative measures for GHG emissions, and different estimation models, including the lagged approach, GMM, and 2SLS, to tackle potential endogeneity issues. Through those additional robustness tests, our main findings remained consistent, suggesting significant negative effects of CEO environmental and cultural values on firm GHG emissions.

Our findings contribute to the literature by examining the underlying cognitions and attitudes of firm CEOs derived from their original countries. Supporting the Upper Echelons Theory, we found that the personal pro-environmental awareness of CEOs impacted the environmental performance of firms, particularly GHG emissions. Amid the heightened issues of global warming and climate change, firms have more intensified expectations and receive scrutiny from different groups of stakeholders, e.g., local pro-environmental groups, the media, and regulators, on their environmental performance. As a result, working toward a 'cleaner' and 'greener' image would substantially enhance their value and reputations. The findings suggest that firms may benefit from appointing CEOs from green countries and cultures, as they are expected to exhibit higher incentives to direct firms toward the achievement of a 'greener' and more sustainable vision. Alternatively, corporations can explicitly and directly promote greener practices to create a substantial pro-environmental working environment for all of their managers and employees. This may enhance their cognitions, views, and attitudes toward environmentalism through higher corporate EPI rather than through country EPI. The study has implications for firms to concentrate on enhancing their environmental performance by focusing on CEO characteristics. The findings of our paper are beneficial for policymakers and investors. Those who are seeking green investment opportunities may consider the environmental practices of firm managers. Similarly, we argue that policymakers may consider future policy amendments regarding corporate claim practices concerning environmental sustainability.

One primary limitation of this study lies in the employment of national measures, such as the Environmental Performance Index (EPI) and Hofstede's cultural values at the country level, as proxies for the environmental values and attitudes of CEOs. This approach may oversimplify complex and individual perspectives on environmental issues. Additionally, the reliance on CEO nationality as a representation of the cultural influence of their background introduces another constraint. CEOs may have different nationalities than the countries where they grew up, received their education, or spent a significant portion of their formative years. This divergence can potentially lead to misinterpretations, as nationality may not accurately reflect the cultural values that shaped the CEO's environmental attitudes. However, it is crucial to acknowledge that, due to data limitations, many studies in the existing literature also face a similar constraint, using CEO nationality as a proxy

for the cultural values of the nations that have influenced them. While this simplification is a common practice in the field, it remains a limitation that should be considered when interpreting the findings of this study. The special characteristics of FTSE250 might make it difficult to generalise the findings to other regions.

Consequently, further research can consider employing manually collected qualitative data through questionnaires, surveys, and/or interviews to explore the true perceptions and attitudes of individual CEOs toward environmental concerns, and how their environmental strategic views and decisions are comprehended in the corporation setting. Furthermore, future research can also extend the scope of our study to other environmental outcomes, including the environmental commitments of firms covering different aspects, such as operational, governance, and supply chain aspects. By taking an expanded perspective, researchers can gain a more holistic view of how CEO environmental values translate into concrete actions within organisations. Embracing a more comprehensive approach, future research can contribute to a richer understanding of the association between the environmental attitudes of individual leaders and the broader environmental commitments of their firms.

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