Journal of Cleaner Production 363 (2022) 132638

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Are gender and cultural diversities on board related to corporate CO2 emissions?

María del Carmen Valls Martínez [a,*], José Manuel Santos-Jaén [b], Rafael Soriano Román [a], Pedro Antonio Martín-Cervantes [a]

[a] Mediterranean Research Center on Economics and Sustainable Development, Economics and Business Department, University of Almería, 04120, Almería, Spain
[b] Department of Accounting and Finance, University of Murcia, 30100, Murcia, Spain

ARTICLE INFO

Handling Editor: Cecilia Maria Villas Bôas de Almeida

Keywords:
Sustainable development
CO2 emissions
Board gender diversity
Board cultural diversity
Developed and developing markets
Gender policies

ABSTRACT

This paper aims to explore whether the female share on the boards of directors of companies influences CO2 emissions in both developed and emerging markets. Furthermore, the influence of cultural diversity on the board of directors on CO2 emissions is analysed. A sample of companies belonging to the MSCI and MSCI Emerging Market indices in Europe over ten years (2010–2019) was analysed using regression models with panel data. The results demonstrate that in both developed and developing markets, the ratio of women to men on the board of directors is inversely related to the company's CO2 emissions, which support legitimacy theory in two aspects: it fulfils the right to equality and non-discrimination for women, and it also reduces CO2 emissions. In general, cultural diversity had a negative influence on CO2 emissions. This research is relevant for policymakers and managers seeking to improve sustainability and equality policies in companies. If gender equality in corporate monitoring roles is environmentally beneficial for the planet, legislators will support quota policies. In addition, shareholders will have an incentive to implement gender equality policies, as they will legitimise the company in the eyes of society, which has economic benefits. On a practical level, this work will contribute to achieving gender equality in corporate governance and improve the understanding of factors influencing CO2 emissions to the environment. This study contributes to previous research since it is the first time that developed and emerging countries have been analysed with the same methodology in relation to gender and CO2 emissions. Moreover, this research differentiates between emission-sensitive and insensitive sectors, and it is the only study to carry out a sector-by-sector and a country-by-country analysis. Furthermore, cultural diversity on corporate boards has been scarcely studied so far in relation to CO2 emissions.

1. Introduction

Concerns about the environment and the effects of climate change have grown considerably in recent years, becoming one of the main topics of interest to the public (Burkhardt et al., 2020). Environmental degradation is primarily due to human activity, especially CO2 emissions, which are considered responsible for numerous major catastrophes worldwide, such as prolonged droughts, devastating fires, tsunamis, floods and cyclones (Shahbaz et al., 2013). Hence, the Kyoto Protocol, agreed in 1997, succeeded in securing the commitment of those adhering countries to effectively reduce CO2 emission. More recently, the Paris Agreement, adopted at the Paris Climate Conference (COP21) in December 2015, provided the basis for preventing climate change by keeping global warming at an optimal target of 1.5 °C and, in any case, below 2 °C. To this end, signatory countries are called upon "to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990" (European Commission, 2020). In addition, the prompt intervention required to tackle climate change and its consequences is addressed in one of the sustainable development goals for 2030 established by the United Nations (Carlsson Kanyama et al., 2018).

Furthermore, the strong emergence of CSR in recent decades has increased companies' awareness of their duty to contribute to

María del Carmen Valls Martínez gratefully acknowledges the support of PPUENTE2022/006 (University of Almería), and Grupo Unicaja and Unicorp Patrimonio corporations for their collaboration.

* Corresponding author.
E-mail addresses: mcvalls@ual.es (M.C. Valls Martínez), jmsj1@um.es (J.M. Santos-Jaén), sr2466@icaalmeria.com (R. Soriano Román), pmc552@ual.es (P.A. Martín-Cervantes).

https://doi.org/10.1016/j.jclepro.2022.132638
Received 5 March 2022; Received in revised form 25 April 2022; Accepted 7 June 2022
Available online 10 June 2022
0959-6526/© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

sustainable development (Santos-Jaén et al., 2021), which, given intense pressure from company stakeholders, has increased in the realisation of sustainable practices. The efforts of companies to improve the environment have contributed to improving their reputations and performance (Fauver et al., 2018).

Nevertheless, not all companies are equally contributing to sustainable development and, in particular, to the reduction in CO2 emissions. Previous literature has tried to shed light on which factors contribute to the greater environmental awareness of companies. For example, it has been demonstrated that family companies may be more committed to environmental protection due to the need to preserve their socio-emotional wealth (Berrone et al., 2010). It has also been shown that the characteristics of a company's board of directors or ownership influence its contribution to environmental conservation (Walls et al., 2012).

The structure of the board of directors has been recognised as an essential driver in the decision making process (Fuente et al., 2017), defining the strategic orientation of the organization (Demb and Neubauer, 1992). In recent years, researchers have become increasingly interested in the role played by women on the board of directors (Hossain et al., 2017). Research on the characteristics of the board of directors and its impact on a firm's environmental performance has shown a relationship between the increased female representation and improved environmental performance (Valls Martínez et al., 2019). A potential explanation is that the female sex may show a greater sensitivity for environmental questions (Xiao and McCright, 2015), and they also tend to be more cautious and thus more aware of the threats that might result from climate change (Burkhardt et al., 2020). Based on gender socialisation theory (Chodorow, 1978), women are expected to be more responsive to the harmful effects that company actions may cause on the environment. It is relevant to highlight that the gender structure of the board of directors is important (Hossain et al., 2017).

Previous research has demonstrated the influence of the stock market on CO2 emissions (Abbasi and Riaz, 2016; Paramati et al., 2017; Tamazian et al., 2009; Zhang, 2011). In effect, the rise of capital markets has driven the growth of companies, expanded their financial sources and increased consumer confidence, leading to increased power requirements and, therefore, CO2 emissions (Sadorsky, 2011). In short, economic development involves a considerable growth in CO2 emissions (Hu et al., 2020). Moreover, securities exchange have contributed to slowing environmental degradation through a series of measures, which have sought to reduce pollution through greener technologies, leading to more efficient energy consumption (Lanoie et al., 1998). In addition, developments in the securities markets have increased their efficiency, making them greater sources of financing for clean energy projects and the renewable energy sector (Kutan et al., 2018). The impact differs depending on whether it is in a developed or emerging market, which may be explained by the varying degrees of implementation of effective policies for CO2 emission reduction; that is, such policies may be more mature in developed markets and incipient in emerging markets (Paramati et al., 2018).

In this paper, we explore whether gender diversity on corporate board is linked to lower CO2 emissions in companies in both developed and emerging markets. Therefore, the key question that we try to answer is the following: Is the proportion of women on company board associated with CO2 emissions in both developed and emerging markets? Additionally, if CO2 emissions are linked to gender diversity, are they also connected to cultural diversity on corporate boards? Moreover, the above relationships are studied by differentiating between industries sensitive and insensitive to CO2 emissions. In addition, the hypotheses are analysed by country and by sector of activity. To test the hypotheses, data from developed and emerging European countries from 2010 to 2019 were used. The methodology used consisted of regression models with panel data.

The main contributions of this study with respect to previous research are the following. First, CO2 emissions and diversity on corporate boards are studied directly instead of from the disclosure of information or the ESG (environmental, social and governance) score. Corporate social responsibility as a whole has been extensively researched. However, when analysing the overall practice, even the environmental aspect, the performance of one variable can mask others. Hence, it is important to study essential aspects such as CO2 emissions individually and directly. We are aware of only a few empirical studies on CO2 emissions and board gender diversity. On the one hand, Haque (2017) found no relationship from a sample of UK companies. On the other hand, Nuber and Velte (2021) and García Martín and Herrero (2020), both studying samples of European companies, found that the increased presence of female members on corporate boards was linked to lower CO2 emissions. However, this is the first time that developed and emerging countries have been analysed separately and with the same methodology. With this approach, similarities and differences can be established. Second, this study reports evidence on cultural diversity on the company board, a variable that has been little studied so far in relation to CO2 emissions. We are aware of only one study involving UK companies (Haque, 2017), which found no relationship, and one international study, which found a negative relationship (Varrone et al., 2020). Third, this is the only study that differentiates between emission-sensitive and -insensitive sectors. Fourth, it is the only study to carry out a sector-by-sector analysis. Fifth, it is the first study to carry out a country-by-country analysis.

Our results show that in both developed and emerging markets, a higher proportion of female members on the board is related to lower CO2 emissions. In general, this relationship remains the same across sectors and countries. This result extends those reported by other researchers who analysed the effects of board gender diversity, and it supports the notion that women likely have a greater concern for environmental conservation (Burkhardt et al., 2020; Kassinis et al., 2016; Liao et al., 2019; Valls Martínez et al., 2019; Xiao and McCright, 2015). The results also reveal that greater cultural diversity is related with higher CO2 emissions.

The rest of the article is structured as follows. The next section presents a description of the most important literature and hypotheses development. The third section describes the data used and the methodology. The fourth section details the results. In the last two sections, the results are discussed, and conclusions of the research are drawn.

2. Literature review and hypotheses development

A company's strategies, policies and objectives are defined by the board of directors (Mason and Simmons, 2014). Therefore, the characteristics of the board may influence not only the performance of the company but also its social and environmental development (Fernández-Gago et al., 2018). Gender diversity is considered one of the most significant dimensions of corporate governance mechanisms (Zaid et al., 2020). Indeed, it is an appealing issue for policymakers, businesses, media and academics in many countries in recent years (Yarram and Adapa, 2021). As a result, several theories have been suggested to clarify different aspects of the effect of business actions based on gender, among which socialisation, social role, resource dependency, legitimacy, agency, stakeholder and stakeholder agency are particularly relevant.

According to gender socialisation theory, women's early childhood experiences, sensitizes them to a concern for the problems of others, making them more susceptible than men to ethical and environmental concerns (Ibrahim et al., 2009). Thus, men and women will have different attitudes towards decisions on ethical or competitive issues (Yarram and Adapa, 2021). In this regard, and according to Liu (2018), these gender differences mean that companies with female directors are less likely to be involved in fraud, tax evasion or unethical practices. This framework has been supported by the results of many surveys that reflect greater concern among women regarding the risk presented by global warming (Wicker and Becken, 2013). In short, because of their particular sensitivities, women are more responsible for environmental matters and unwilling to take legally or morally punishable actions, such as environmental pollution (Bear et al., 2010; Choi and Park, 2014; Nielsen and Huse, 2010; Valls Martínez et al., 2019).

In a similar vein, social role theory suggests that due to women's specific responsibilities for child-rearing and household care, the difference between women and men lies not in their nature but in their education (Mateos del Cabo et al., 2010). According to this theory, people behave according to stereotypes and beliefs (Eagly et al., 2003), which will lead to a different management style based on gender. In particular, women show greater sensitivity and empathy towards the problems presented by stakeholders, including environmental issues (Bernardi and Threadgill, 2010; Liao et al., 2019). It is in this way that women and men play gendered roles within organisations. Therefore, companies with women in senior monitoring positions focus more on stakeholders and their interests (Yarram and Adapa, 2021).

From the perspective of resource dependency theory, companies must relate to their environment and the most important channel for interaction is their board of directors (Pfeffer, 1973). Under this concept, if the environment changes, so do the required resources, which affects the board of directors. Thus, the more diverse the board of directors, the greater its power to access the required funds and meet its social and environmental obligations (Valls Martínez et al., 2020). As considerable portion of human capital, women managers can help link the company to its environment (Tingbani et al., 2020).

Agency theory arises from the distinction between ownership and control (Jensen and Meckling, 1976), which leads managers to act in their own self-interest, to the detriment of shareholders. In order to carry out activities to address environmental problems, managers have to incur costs, which reduce shareholder returns (Hossain et al., 2017). These agency costs can be mitigated by reducing information asymmetry and increasing transparency and accountability. On this basis, the greater presence of women on corporate boards increases the likelihood of performing audits, leading to a reduction in environmentally harmful practices (Liao et al., 2019; Valls Martínez et al., 2020). In short, gender diversity strengthens the independence of the board of directors, enhancing commitment to environmental activities and their dissemination (Zaid et al., 2020; Hillman et al., 2007). Evidence has shown that gender diversity on corporate board increases the disclosure of company information (Gul et al., 2011).

The stakeholder theory argues that stakeholders (shareholders, customers, suppliers, lenders, governments and others) are interested in financial and non-financial outcomes, including environmental ones. According to this theory, companies operate in society and are responsible for repairing the damage created through environmental pollution (Freeman, 1984). Women's more demanding morality on these issues makes companies more inclined to meet stakeholder demands (Francoeur et al., 2019). In this vein, Al-Shaer and Zaman (2016) stated women on boards tend to be more concerned about companies behaving ethically and adopting socially responsible practices, i.e., being more stakeholder-oriented.

Finally, combining the last two theories gives rise to the stakeholder agency theory (Hill and Jones, 1992). This theory considers the board to be simultaneously the principal of the management and the agent of the stakeholders (Valls Martínez et al., 2020). Gender-diverse boards tend to mitigate information asymmetries between shareholders and management and, therefore, avoid conflicts between the two groups involved (Shankman, 1999) and enhances corporate reputation (Francoeur et al., 2019). Based on this theory, Francoeur et al. (2019) showed that the board of directors had greater independence if it had a higher percentage of women. Nevertheless, Prado-Lorenzo and Garcia-Sanchez (2010) found that the percentage of women on corporate boards had no influence on the disclosure of greenhouse gas emission information.

Although all of the above theories relate board diversity to the adoption of environmental measures, such as CO2 emission reductions, legitimacy theory best reflects this linkage. Based on legitimacy theory, through a social contract (O'donovan, 2002), society regards corporations as socially responsible. The degree of stakeholder acceptance of the company as a moral corporate citizen depends on the moral legitimacy conferred by the outcome of its social responsibility actions. A company has legitimacy in the eyes of its stakeholders when its actions are generally considered to be according to the prevailing system of norms, values and beliefs (Scherer and Palazzo, 2007). Certainly, companies are obliged to comply with current legislation, but beyond that, they must also abide by the standards accepted by the society in which they operate in order to be accepted. Only by achieving this legitimacy will they be able to obtain the necessary resources. Otherwise, their growth and even their very survival will be endangered (Oliver, 1991).

According to the theory of legitimacy, we can consider the volume of CO2 emissions as a reflection of the moral legitimacy of the company (Zhang et al., 2013). Thus, although costly for companies, measures to control such emissions will provide them with the benefits derived from social acceptance, which will result in higher sales, easier access to credit, etc. In summary, emission reduction can lead to higher financial returns. Female members of corporate boards can contribute to increasing the company's legitimacy in two ways. On the one hand, women's particular psychological characteristics mean that they are more sensitive to stakeholder grievances, which increases CSR performance (Gennari, 2018; Scherer and Palazzo, 2007). On the other hand, if women manage to increase company resources, these entities will be in a better financial position to take the necessary measures to reduce CO2 emissions and meet stakeholder expectations (Zhang et al., 2013).

It is important to note that legitimacy may vary depending on the context, so what is legitimate in one industry may not be legitimate in another (Campbell, 2006; Moore, 2001). Similarly, what is considered legitimate may differ from one country to another. Stakeholders are different, and moral norms and values are rooted in each culture or type of industry. Therefore, we consider it essential to check whether the hypotheses put forward in this article hold in different sectors of activity and different countries.

Applying these theories, preceding research has attempted to relate the share of women on the board of directors to environmental issues, such as environmental policies, disclosure of information on polluting activities, etc. The results are heterogeneous, and, in addition, few studies have addressed the relationship between female directors and CO2 emissions.

According to the above, we predict that a greater proportion of female board members is expected to be associated with lower CO2 emissions in both developed and emerging markets. Thus, we establish the following hypothesis:

Hypothesis 1. There is a negative relationship between the proportion of women on the board of directors and CO2 emissions.

As a result of globalisation, companies are becoming increasingly multicultural (Ahmad and Amin, 2020), which implies the involvement of multiple perceptions, beliefs, habits, religions, educational backgrounds, information gathering and handling as well as management styles (Varrone et al., 2020). Hence, it is important to study the effects of cultural diversity on corporate boards. Gender diversity on the board of directors and its effect on corporate performance have been extensively studied (Erhardt et al., 2003; Masulis et al., 2012; Müller, 2014). Nevertheless, there is a dearth of studies that address other board variables such as cultural diversity, especially in developing countries (Zaid et al., 2019), which is necessary to understand because culture is an essential factors determining decision making (Frijns et al., 2016).

There are contradictory arguments in the literature on the influence of the cultural diversity of corporate boards (Al-Qahtani and Elgharbawy, 2020). On the one hand, the agency theory supports that extensive and diverse boards are more likely to have problems in achieving agreements due to less fluid communication (Beji et al., 2021). Cultural diversity can lead to conflicts between different groups within the company, generating agency costs and asymmetric information problems (Amin et al., 2021; Cao et al., 2019; Ibrahim and Hanefah, 2016).

On the other hand, based on resource dependency theory, large and diverse boards provide access to wider resources through the connections and talents of their members, while also giving them greater legitimacy in the eyes of society (Ibrahim and Hanefah, 2016). This reasoning suggests that culturally diverse firms have more robust information, in quantity and quality (Carter et al., 2010). As a result of the different ideas and values arising from cultural diversity, the more diverse the board is, the more able it is to perceive and meet the needs of a broader scope of stakeholders, resulting in an open-minded company (Martínez-Ferrero et al., 2021).

It is worth noting that the analysis of group behaviour has shown that the more homogeneous groups become, the lower the barriers to communication between them, although there are pressures to conform to group thinking that can establish more relaxed supervisory norms (Upadhyay and Zeng, 2014). Continuing this contradictory debate, Rao and Tilt (2016) and Zaid et al. (2020) stated that cultural diversity on boards leads to higher quality decisions on social and environmental issues, promoting greater corporate sustainability. On the contrary, Miller and Triana (2009) argued that cultural homogeneity among board members can weaken the quality of the debate and, thus, can compromise the decisions made. Concerning environmental issues, Liao et al. (2015) suggested that climate-related programmes are more complex in their implementation due to the number of stakeholders involved.

This contradiction among theories is also reflected in the results obtained in recent empirical studies. For example, Haque (2017) found no relationship between the diverse characteristics of a company's board of directors, whereas Varrone et al. (2020) found that the greater the diversity on the board, the higher the sustainability performance. Diversity is seen as a double-edged *sword*, bringing both advantages and drawbacks. The final outcome will depend on the overall weights of the positive and negative aspects.

Based on the above, in order to shed some light on the contradiction, we establish the following hypothesis:

Hypothesis 2. There is a positive relationship between the board cultural diversity and CO2 emissions.

3. Dataset and methodology

3.1. The dataset

The empirical analysis was conducted using data obtained from the Bloomberg database concerning the Morgan Stanley Capital International (MSCI) indexes for Europe, specifically the MSCI Europe index and the MSCI Emerging Market (MSCI EM) Europe index. The first one includes mid-sized and large companies from 15 developed European countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom; the second one comprises firms from 6 European emerging markets: Czech Republic, Greece, Hungary, Poland, Russia and Turkey. Therefore, two parallel analyses were carried out to test whether or not companies operating in developed countries behave in the same way as those located in emerging countries with respect to the study hypotheses. A study was also developed by sector of activity, distinguishing between sensitive and insensitive sectors to CO2 emissions.

The sample covers ten years (2010–2019) and comprises a total of 6233 observations for the MSCI index and 404 observations for the MSCI EM index. Observations with missing data for any of the variables were eliminated to ensure the robustness of the analysis (Liao et al., 2019).

Bloomberg database is a professional database used by private and collective investment portfolio managers, so our data is reliable and closely related to the financial world. In addition, it is accepted in research, as shown by the publication of previous works on corporate social responsibility and gender (G Giannarakis et al., 2014; Grigoris Giannarakis et al., 2014; Nollet et al., 2016). The MSCI indexes are also highly regarded by practitioners and academics and have been used in numerous research studies concerning women and corporate social responsibility (Diez-Cañamero et al., 2020; Jain et al., 2019; Liang and Renneboog, 2017; Lopatta et al., 2016; Peillex et al., 2021).

The mean values of the dependent and independent variables by sector are reported in Table 1. The sectors with the highest CO2 emissions are energy, utilities, consumer non-cyclical, and basic materials, whereas technology has the lowest value. With respect to gender diversity on corporate boards, the sectors with the highest percentage of women are technology, consumer cyclicals and healthcare, while utilities, telecommunications services and energy are less diverse. Therefore, a specific inverse relationship is observed between the level of CO2 emissions and the ratio of women on the board of directors. However, in terms of cultural diversity on the board of directors, the consumer non-cyclical and utilities sectors are among the most polluting and the most culturally diverse, after healthcare.

3.2. Variable description

Table 2 describes the variables included in the empirical analysis and the abbreviations used hereafter. The dependent variable is total CO2 and CO2 equivalent emissions in tonnes (CO2); the logarithm was calculated according to the size of the regression coefficients. None of the studies carried out to date (García Martín and Herrero, 2020; Haque, 2017; Nuber and Velte, 2021) have conducted a comparative analysis between developed and emerging European countries.

The main independent variable and object of study is the percentage of women on the corporate board (BDG), which reflects board gender diversity in monitoring positions. Previous literature has positively related the share of women on the board of directors to greater implementation and disclosure of corporate social responsibility measures in general (Ben-Amar et al., 2017; Boulouta, 2013; Burkhardt et al., 2020b; Francoeur et al., 2019b; Giannarakis, 2014; Zhang et al., 2013) and sustainability practices in particular (Bernardi and Threadgill, 2010; Charumathi and Rahman, 2019; Hossain et al., 2017; Kyaw et al., 2017; Liao et al., 2019; Nuber and Velte, 2021; Tingbani et al., 2020). However, the direct relationship with CO2 emissions, which is one of the greatest environmental concerns of the international community, has been rarely studied. Most of these studies analysed the influence of women on the disclosure of information about greenhouse gas emissions, and their results indicate a positive relationship (Ben-Amar et al., 2017; Elsayih et al., 2018; Hollindale et al., 2019; Kılıç and Kuzey, 2019; Tingbani et al., 2020). Only a few previous analyses have directly studied the link between the increased presence of women on corporate boards and the volume of CO2 emissions, and they have found that the relationship is non-existent (Haque, 2017) or negative (García Martín

Table 1
Sample description.

	Percent	CO2 Mean$^{(+)}$	BGD Mean$^{(\dagger)}$	BCD Mean$^{(*)}$
1. Basic Materials	9.205	13.025	27.054	43.366
2. Consumer Cyclicals	15.068	12.682	28.553	42.693
3. Consumer Non-Cyclicals	7.198	13.048	27.720	46.965
4. Energy	5.567	13.521	24.183	42.282
5. Financials	22.968	12.625	27.001	42.605
6. Healthcare	6.882	12.628	28.225	48.134
7. Industrials	19.547	12.638	28.160	43.142
8. Technology	5.764	12.573	28.818	44.775
9. Telecommunications Services	3.994	12.874	25.863	41.125
10. Utilities	3.807	13.299	26.738	45.699

$^{(+)}$Mean of the logarithm of total CO2 and CO2 equivalent emission in tonnes.
$^{(\dagger)}$Mean of the percentage of women on board of directors.
$^{(*)}$Mean of the percentage of members on board of directors with a cultural background different from those of the company's headquarters.

Table 2
Description of variables.

Abbreviation	Variable	Definition
CO2	Ln CO2 Emission	Logarithm of total CO2 and CO2 equivalent emission in tonnes
BGD	Board Gender Diversity	Percentage of board members who are women
BCD	Board Cultural Diversity	Percentage of board members with a cultural background different from those of the company's headquarters
MTB	Market to Book	The market value divided by the book value
PER	Price Earnings Ratio	The company's stock price divided by the earnings per share (daily time series ratio)
ROA	Return on Assets	Profit to total assets, percent
REV	Ln Revenue	Logarithm of revenue
IND	Indebtedness	Total debt to total equity, percent
PEM	Policy Emissions	Dummy variable, 1 if the company has a policy to improve emission reduction and 0, otherwise
TEM	Target Emissions	Dummy variable, 1 if the company has set targets for emission reduction and 0, otherwise
EEI	Environmental Expenditures Investments	Dummy variable, 1 if the company reports on its environmental expenditures investments to minimize future risks or increase opportunities and 0, otherwise.
PEE	Policy Energy Efficiency	Dummy variable, 1 if the company has a policy to improve its energy efficiency and 0, otherwise
BIR	Biodiversity Impact Reduction	Dummy variable, 1 if the company reports on its impact on biodiversity or activities to reduce its impact on the native ecosystems and species, as well as the biodiversity of protected and sensitive areas
IBM	Independent Board Members	Percentage of independent board members
PBD	Policy Board Diversity	Dummy variable, 1 if the company has a gender diversity policy on the board of directors and 0, otherwise
DCS	Day-care Services	Dummy variable, 1 if the company provides, day-care services and 0, otherwise
HRP	Human Rights Policy	Dummy variable, 1 if the company has a policy to ensure the respect of human rights and 0, otherwise
EGD	Executive Members Gender Diversity	Percentage of female executive
BSS	Board Specific Skills	Percentage of board members who have either an industry specific background or a strong financial background
EME	Developed/Emerging	Dummy variable, 1 if the company's headquarters is located in an emerging country and 0, otherwise
SES	Sensitive Sector	Dummy variable, 1 if the company belong to a CO2 emission sensitive sector (basic materials, consumer non-cyclicals, energy and utilities) and 0, otherwise

and Herrero, 2020; Nuber and Velte, 2021).

Cultural diversity on the corporate board (BCD), represented by the percentage of board members with a cultural background different from that of the company's headquarters, is also an independent variable whose relationship with CO2 emissions was analysed in the study. This variable has only been considered previously in relation to CO2 emissions in an analysis on disclosure (Kılıç and Kuzey, 2019), and the results showed a positive relationship.

The present study included three groups of control variables: financial market, financial accounting and environmental policy variables. Financial market variables reflect the long-term expectations of the company according to investors; specifically, the market-to-book (MTB) and price-earning (PER) ratios were considered, as is common in the literature (Ben-Amar et al., 2017; Joecks et al., 2013; Valls Martínez and Cruz Rambaud, 2019). It seems logical that the market would positively value lower CO2 emissions to the atmosphere, so the relationship with the dependent variable would be negative. However, some previous empirical studies found a positive link (Elsayih et al., 2018; Hollindale et al., 2019; Hossain et al., 2017), whereas other works identified a negative association (Prado-Lorenzo and Garcia-Sanchez, 2010), and a sizable proportion of the analyses even show differing interactions depending on the model used (Ben-Amar et al., 2017; Haque, 2017; Nuber and Velte, 2021). In any case, the relationships are not always significant.

The accounting variables represent the current situation of the company derived from past events and management. In particular, the return on assets (ROA), the logarithm of revenues as an indicator of the company's size (REV) and the debt ratio as a reflection of the financial situation (INDEB) were used, as reported in the literature (Aslam et al., 2018; Dienes and Velte, 2016; Francoeur et al., 2019; Furlotti et al., 2019; Kyaw et al., 2017; Prado-Lorenzo et al., 2012; Reverte, 2009; Zhang et al., 2013). The relationship between these variables and CO2 emissions has varied in previous studies, either in sign or significance.

Valls Martínez et al. (2020) represented the company's involvement in CSR policies by using four dummy variables indicating whether the company applied energy efficiency policy; reported on crisis management systems; had received any awards for its social, ethical, community or environmental activities; and had a CSR committee. Following this line of reasoning, five dummy variables were ultimately used to capture the company's environmental commitment. In this regard, it was considered whether or not the company: (1) had policies to improve emission reduction (PEM); (2) had set for emission reduction (TEM); (3) reported on its environmental expenditures investments to minimize future risk or increase opportunities (EEI); (4) had policies to improve its energy efficiency (PEE); (5) reported on its impact on biodiversity or activities to reduce its impact on native ecosystems and species, as well as the biodiversity of protected and sensitive areas (BIR). In all of these cases, a positive relationship with CO2 emissions is expected.

As is standard in this line of study, and considering that the most polluting industries are subject to specific legal and moral regulations to mitigate their adverse effects on the environment, dummy variables were included to indicate whether the company belongs to a CO2 emission-sensitive sector (Ben-Amar et al., 2017; Kılıç and Kuzey, 2019; Prado-Lorenzo and Garcia-Sanchez, 2010). Specifically, basic materials, consumer non-cyclical, energy and utilities sectors were considered sensitive.

Finally, according to the aim of this research, a dummy variable was included to indicate whether the company belongs to a developed or emerging country (Luo et al., 2013) to determine if company location is a determining factor in CO2 emissions.

Reverse causality between CSR performance and gender-diverse boards of directors has been addressed in the literature by using instrumental variables to determine the percentage of women on the board of directors (Ben-Amar et al., 2017; Garcia-Castro et al., 2010; Kyaw et al., 2017). As reducing CO2 emissions is a component of CSR, the female members on the board can be estimated through instrumental variables, establishing parallelism between the two relationships (Elsayih et al., 2018; Haque, 2017; Nuber and Velte, 2021). Because most European countries have quota legislation (Valls Martínez and Cruz Rambaud, 2019), it is expected that a wide range of women are appointed among the independent directors, so the percentage of independent board members (IBM) is used as an instrumental variable (Valls Martínez et al., 2019). If the corporation is sensitive to women in executive positions, then it should be more likely to have women on the board, so executive member gender diversity (EGD) is also used as an instrument. Companies that pursue gender diversity policies on the board (PBD), have more day-care services (DCS) and implement human rights policies (HRP) are also more likely to have more women on their boards, so these variables were also used as instruments. Finally, if directors are chosen for their specific skills and not based on quotas, it is more likely that there will be more male directors since, despite the advancement of women in training, it is still a reality today that there is a glass ceiling that hampers women from reaching the best seats (Mateos del Cabo et al., 2010). Therefore, the percentage of board members with either an industry-specific background or a solid financial background (BSS) was considered an instrumental variable.

3.3. Methodology

First, after analysing the main descriptive statistics of all of the variables involved in the study and their bivariate correlations, a *t*-test was performed to compare developed and emerging countries. We aimed to identify differences between the means of the variables and their significance according to the location of the company. Similarly, the differences between countries with high and low percentages of women on boards of directors were analysed. For this purpose, a dummy variable was constructed, and its mean value was taken as a reference. In addition, a *t*-test was also performed to identify differences between companies located in countries sensitive and insensitive to CO2 emissions, as well as between companies with high and low cultural diversity on corporate boards.

Second, an Ordinary Least Squares (OLS) estimation was performed to check the linear relationship between the percentage of women on the company board and the CO2 emissions. To address potential endogeneity caused by the influence of other variables, and following the literature, the lagged dependent variable was included as a regressor with a lag period (Francoeur et al., 2019; Lin et al., 2018; Orlitzky and Bejamin, 2001; Reguera-Alvarado et al., 2017; Sial et al., 2018; Zhang et al., 2013). An estimation was made for the total number of observations. Subsequently, the sample was divided into developed and emerging countries. Additionally, the sample was also divided into two subsamples, depending on whether the company belongs to a CO2 emission-sensitive sector or not. Thus, a total of five estimations were made.

Third, cross-sectional data were combined with time series in a panel data analysis to control for the problem of omitted variables. In this case, the Hausman test was applied to determine whether the fixed-effects model is more appropriate than the random-effects model, which occurs when the unobservable heterogeneity among the different firms is correlated with the explanatory variables (Campbell and Mínguez-Vera, 2008; Miralles-Quiros et al., 2017). The individual evaluation of each model was assessed through the *F*-statistic and the R^2 coefficient. The first one determines the joint significance of all model parameters when the *p*-value is less than 0.05. The second one reveals the proportion of the dependent variable explained by the set of regressors. Finally, the performance of the OLS and panel data models was ranked using the Akaike and Bayesian Information Criteria (AIC and BIC); the best fit of the model is given by lower values.

Fourth, after identifying the best model, which corresponded to fixed effects, the second variable under study, i.e., cultural diversity, was incorporated. The final joint model was obtained both for the total sample and for each of the four subsamples.

Fifth, considering the diversity of the sample, the data by country were analysed. The countries with the largest number of observations were included in the analysis to increase the reliability of the results. An analysis was also performed for individual sectors to examine potential differences depending on the sector to which the company belongs.

The literature refers to more advanced econometric techniques to deal with endogeneity problems resulting from the influence of other variables, omitted variables not considered in the analysis and reverse causality between the explained variable and the regressor. Therefore, different strategies were implemented to test the robustness of the fixed-effects model, including the two dependent variables. (1) A fixed-effects estimation with instrumental variables was applied. The percentage of women on corporate boards was replaced by the estimation made with the five instruments described above and the rest of the regressors (Elsayih et al., 2018; Haque, 2017). (2) A second-order generalised moment method (GMM) estimation was implemented, which is more efficient and consistent than the first-order model and has the advantage of preventing unnecessary data loss (Arellano and Bover, 1995). (3) To estimate CO2 emissions, we used the residuals resulting from the estimation of this variable with the rest of the regressors instead of the share of women on corporate boards. That is, the main model used only the variance in the BGD variable not explained by the rest of the variables as a measure to deal with endogeneity (Tingbani et al., 2020). (4) In addition, the estimation of the baseline model with the winsorised variables was performed to test the stability of the results (Haque, 2017).

4. Results

4.1. Descriptive statistics and bivariate relationships

Table 3 summarises the most relevant statistics of the variables. The average share of women on corporate boards is 27,495, ranging from a minimum of 0 to a maximum of 71,429, which shows that, on average, gender equality is far from achieved. This is despite the fact that almost 74% of companies claim to have a board diversity policy, more than 90% declare the enforcement of human rights policies, and an average of 63% of board members are independent. Nevertheless, female executives are still present at a much lower average of 13.7%. On the contrary, the other variable under study, cultural diversity, has a remarkable mean value of 43.675, ranging from 0 to 100.

With regard to environmental performance, more than 90% of the companies apply emission reduction and energy efficiency policies, 73% have set emission targets, and slightly more than 40% make environmental investments and are concerned about reducing their impact on biodiversity. Of the total sample analysed, 81% of the companies are located in developed countries, and 25.8% belong to CO2 emission-sensitive sectors.

The *t*-test results, shown in Table 4, reveal that the differences in means of the variables between developed and emerging countries are all significant, except for ROA. Companies located in developed countries show lower average CO2 emissions, more gender and cultural diversity, better market valuation, higher debt levels and more proactive actions in implementing environmental policies (PEM, TEM and PEE),

Table 3
Descriptive statistics.

Variable	Mean	Median	SD[(+)]	Minimum	Maximum
CO2	12.786	12.605	2.712	0.693	19.083
BGD	27.495	28.571	12.674	0.000	71.429
BCD	43.675	33.333	31.331	0.000	100.000
MTB	3.688	2.019	19.839	−585.342	762.043
PER	31.269	17.088	161.913	0.055	6803.635
ROA	5.623	4.472	9.894	−75.560	237.411
REV	21.879	21.754	2.056	3.937	29.739
IND	123.283	62.549	333.519	0.000	13729.900
PEM	0.919	1.000	0.273	0.000	1.000
TEM	0.731	1.000	0.443	0.000	1.000
EEI	0.467	0.000	0.499	0.000	1.000
PEE	0.939	1.000	0.239	0.000	1.000
BIR	0.412	0.000	0.492	0.000	1.000
IBM	62.880	64.286	23.796	0.000	100.000
PBD	0.736	1.000	0.441	0.000	1.000
DCS	0.324	0.000	0.468	0.000	1.000
HRP	0.908	1.000	0.289	0.000	1.000
EGD	13.717	12.500	11.528	0.000	75.000
BSS	39.976	40.000	20.207	0.000	100.000
EME	0.810	0.000	0.273	0.000	1.000
SES	0.258	0.000	0.438	0.000	1.000

[(+)]Standard Deviation.

Table 4
Difference of means test (*t*-test) in the value of the variables in developed/emerging countries and by board gender diversity.

Variables	Developed/Emerging Countries			Board Gender Diversity(†)		
	Mean developed countries	Mean emerging countries	Difference(+)	Mean BGD ≤27.5	Mean BGD >27.5	Difference(+)
CO2	12.728	13.523	−0.795*** (0.0000)	12.948	12.631	0.317*** (0.0000)
BGD	28.883	9.792	19.091*** (0.0000)			
BCD	45.062	22.467	22.595*** (0.0000)	43.670	43.679	−0.009ns (0.5052)
MTB	3.854	1.888	1.966*** (0.0000)	3.664	3.709	−0.045ns (0.9106)
PER	32.637	17.029	15.608** (0.0112)	31.003	31.505	−0.502ns (0.8855)
ROA	5.576	6.112	−0.536ns (0.1478)	5.821	5.451	0.370* (0.0764)
REV	21.704	24.230	−2.526*** (0.0000)	21.960	21.808	0.152*** (0.0005)
IND	125.707	96.776	28.931** (0.0162)	119.566	126.591	−7.025ns (0.2928)
PEM	0.935	0.710	0.225*** (0.0000)	0.892	0.944	−0.052*** (0.0000)
TEM	0.760	0.355	0.405*** (0.0000)	0.697	0.763	−0.066*** (0.0000)
EEI	0.457	0.587	−0.130*** (0.0000)	0.490	0.445	0.045*** (0.0000)
PEE	0.943	0.877	0.066*** (0.0000)	0.926	0.951	−0.025*** (0.0000)
BIR	0.407	0.479	−0.072*** (0.0000)	0.381	0.441	−0.060*** (0.0000)
IBM	65.066	35.021	30.045*** (0.0000)	60.031	65.635	−5.603*** (0.0000)
PBD	0.785	0.120	0.665*** (0.0000)	0.655	0.814	−0.159*** (0.0000)
DCS	0.337	0.152	0.185*** (0.0000)	0.271	0.374	−0.103*** (0.0000)
HRP	0.936	0.546	0.390*** (0.0000)	0.866	0.948	−0.082*** (0.0000)
EGD	13.848	12.031	1.817*** (0.0000)	11.127	16.215	−5.088*** (0.0000)
BSS	40.027	39.322	0.705*** (0.0000)	42.889	37.154	5.736*** (0.0000)
EME				0.134	0.033	0.101*** (0.0000)
SES	0.245	0.412	−0.167*** (0.0000)	0.273	0.245	0.028*** (0.0009)

(†) By considering the mean of Board Gender Diversity, a dummy variable was created taking the value 1 if the percentage of women on corporate board was greater than 27.5 and 0, otherwise.
(+) p-value in parentheses.
ns denotes non-significant.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

but they report on them less (EEI and BIR) and are less frequently in CO2-sensitive sectors.

The means test on gender diversity on the board of directors reveals that companies with more gender diversity have lower average CO2 emissions and apply more environmental protection measures on average. Moreover, they promote women's employment through day-care services and their application for executive positions. These companies are more abundant in developed countries and in sectors that are not sensitive to CO2 emissions.

Table 5 reports the results of the means difference test between insensitive and sensitive sectors. The more sensitive sectors have a lower average number of female board members, have higher average sales and lower debt levels, have higher emission targets (TEM), provide more information on their expenditures to mitigate adverse impacts (EEI and BIR) and are predominantly located in emerging countries.

Finally, the *t*-test results for cultural diversity reveal that higher diversity corresponds to lower emission reduction and energy efficiency policies, higher gender diversity policies and more female executives.

Table 5
Difference of means test (*t*-test) in the value of the variables in non-sensitive/sensitive sectors and by board cultural diversity.

Variables	Non-sensitive/Sensitive sectors			Board Cultural Diversity(†)		
	Non-sensitive sectors	Sensitive sectors	Difference(+)	Mean BCD ≤27.5	Mean BCD >27.5	Difference(+)
CO2	12.650	13.179	−0.429*** (0.0000)	12.748	12.821	−0.073ns (0.1743)
BGD	27.816	26.573	1.243*** (0.0000)	27.382	27.600	−0.218ns (0.3875)
BCD	43.391	44.480	−1.089ns (0.1657)			
MTB	3.908	3.080	0.828* (0.0686)	3.346	3.984	−0.638ns (0.1137)
PER	32.554	27.546	5.008ns (0.2087)	35.734	27.425	8.309** (0.0172)
ROA	5.766	5.221	0.545** (0.0211)	5.660	5.591	0.069ns (0.7424)
REV	21.496	22.801	−1.305*** (0.0000)	21.848	21.905	−0.057ns (0.1914)
IND	134.834	91.068	43.766*** (0.0000)	119.778	126.328	−6.550ns (0.3270)
PEM	0.919	0.917	0.002ns (0.6915)	0.927	0.912	0.015*** (0.0051)
TEM	0.725	0.749	−0.024** (0.0159)	0.736	0.727	0.009ns (0.2969)
EEI	0.450	0.514	−0.064*** (0.0000)	0.459	0.473	−0.014ns (0.1509)
PEE	0.937	0.943	−0.005ns (0.3039)	0.951	0.928	0.023*** (0.0000)
BIR	0.398	0.450	−0.052*** (0.0000)	0.420	0.405	0.015ns (0.1264)
IBM	62.950	62.678	0.272ns (0.6152)	61.967	63.721	−1.754*** (0.0002)
PBD	0.745	0.710	0.035*** (0.0005)	0.720	0.752	−0.032*** (0.0002)
DCS	0.323	0.326	−0.003ns (0.7498)	0.337	0.311	0.026*** (0.0045)
HRP	0.912	0.895	0.017*** (0.0082)	0.903	0.912	−0.009ns (0.1196)
EGD	13.867	13.283	0.584** (0.0258)	14.049	13.409	0.640*** (0.0052)
BSS	40.126	39.545	0.581ns (0.2069)	39.673	40.255	−0.582 (0.1486)
EME	0.064	0.129	−0.065*** (0.0000)	0.091	0.072	0.019*** (0.0004)
SES				0.255	0.261	−0.006ns (0.5062)

(†) By considering the mean of Board Cultural Diversity, a dummy variable was created taking the value 1 if the percentage of board members with a cultural background different from those of the company's headquarters was greater than 43.7 and 0, otherwise.
(+) p-value in parentheses.
ns denotes non-significant.
***,** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

Furthermore, cultural diversity is higher in developed countries.

Table 6 shows the Pearson correlation between continuous variables. The absence of high correlations between regressors indicates that there are no collinearity problems. The correlation between CO2 emissions and board gender diversity is negative and significant. Therefore, the stronger the presence of women in managerial positions, the lower the CO2 emissions. However, the opposite is true for cultural diversity. Moreover, the dependent variable is significantly and negatively correlated with the variable showing market valuation (MTB) and positively correlated with the firm size variable (REV) and with the five environmental variables (PEM, TEM, EEI, PEE and BIR). Furthermore, CO2 emissions are significantly correlated with the market type and sector dummy variables, so emissions are higher in emerging countries and sensitive sectors.

Board gender diversity is significantly correlated with instrumental and environmental variables. The data also indicate that a higher percentage of women on the board of directors is correlated with greater cultural diversity (BGD), higher market valuation (MTB) and smaller company size (REV). In addition, developed countries and insensitive sectors display increased board gender diversity.

On the other hand, board cultural diversity presents a significant correlation only with some environmental variables and with the country dummy variable, with the most culturally diverse boards located in developed countries.

Notably, companies in sensitive sectors are primarily located in emerging countries.

Fig. 1 depicts the scatter graphs derived from the real and adjusted values of the dependent and independent variables for each of the four sub-samples. In all cases, CO2 emissions are negatively linked to gender diversity on corporate boards. However, this relationship is positive with cultural diversity on the corporate boards, except in emerging countries.

4.2. Regression analysis

Table 7 provides the results of Model 1 applied to companies included in the MSCI Europe and MSCI EM Europe indices from 2010 to 2019. The OLS estimation reveals a negative and significant relationship, with a significance level of less than 1% (p-value < 0.01), between the share of women on corporate boards and CO2 emissions. This behaviour is verified in the total observations and the four subsamples, with an adjustment coefficient R^2 ranging from 43.03% to 49.43%. The model does not present multicollinearity problems since the variance inflation factors (VIF) have a maximum value of 2.49, far from the critical value of 10 (Fox and Monette, 1992).

Next, in Model 2, which is presented in Table 8, data were handled as a panel to deal with the problem of omitted variables. The Hausman test yielded a p-value of less than 0.05 in all cases, so the fixed-effects models are appropriate. Model 2 outperforms Model 1 in terms of AIC and BIC. The results obtained concerning the relationship and significance between the dependent and board gender diversity variables remain consistent with prior analyses.

Finally, in Model 3, shown in Table 9, the board cultural diversity variable was incorporated. Model 3 is preferable to Model 2. Therefore, Model 3 is the best of the proposed models. The AIC and BIC values are lower, and the R^2 coefficient is higher in Model 3. Specifically, between 45.95% and 60.43% of CO2 emissions are explained.

The share of women on corporate boards presents a negative and highly significant relationship with CO2 emissions, both in the total sample and in the particular cases of developed and emerging countries and the insensitive and sensitive sectors. Therefore, Hypothesis 1 is confirmed.

Cultural diversity on the board of directors shows a positive and significant relationship with the dependent variable in all cases, except for emerging countries, where the relationship is not significant, which is in line with the graphs in Fig. 1 above. In the subsample of emerging countries, the different behaviour of this variable, as well as that of most of the other variables, may be due to the fact that these countries behave differently or that the sample size is not large enough to capture the behaviour of the variables. Considering the results obtained, we can state that Hypothesis 2 is also mostly confirmed.

Furthermore, in general terms, the results suggest that larger companies (higher revenues) are associated with less pollution, and companies that claim to apply environmental policies are linked to more CO2 emissions.

Additionally, applying Model 3 by sector, it is observed that the relationship between board gender diversity and CO2 emissions is always negative. Moreover, it is significant in seven of the ten sectors, as shown in Table 10. Therefore, in a sector-by-sector analysis, Hypothesis 1 remains consistent. Regarding the cultural diversity hypothesis, the relationship remains positive in nine sectors and significant in eight sectors. Nevertheless, in the technology sector, it shows an inverse

Table 6
Pearson correlations between continuous variables.

Variable	CO2	BGD	BCD	MTB	PER	ROA	REV	IND	IBM	EGD
BGD	−0.0875***									
	(0.000)									
BCD	0.1285***	0.0276**								
	(0.0000)	(0.0443)								
MTB	−0.0212*	0.0218*	−0.004							
	(0.0840)	(0.0756)	(0.9796)							
PER	0.0075	−0.0022	−0.0180	0.0061						
	(0.5438)	(0.8557)	(0.1890)	(0.6206)						
ROA	0.0004	−0.0180	−0.014	0.5436***	−0.0600***					
	(0.9772)	(0.1433)	(0.9180)	(0.0000)	(0.0000)					
REV	0.2285***	−0.0715***	0.0266*	−0.0922***	−0.0163	−0.1536***				
	(0.0000)	(0.0000)	(0.0524)	(0.0000)	(0.1839)	(0.0000)				
IND	0.0023	0.0172	−0.0074	0.4403***	0.0018	−0.0696***	0.0128			
	(0.8509)	(0.1601)	(0.5919)	(0.0000)	(0.8828)	(0.0000)	(0.2956)			
IBM	0.0597***	0.1731***	0.1044***	0.0052	0.0027	−0.0072	−0.0067	0.0062		
	(0.0000)	(0.0000)	(0.0000)	(0.7063)	(0.8472)	(0.6028)	(0.6250)	(0.6539)		
EGD	−0.0513***	0.2952***	−0.0407***	0.0263*	−0.0101	0.0225	0.0094	−0.0120	0.0041	
	(0.0002)	(0.0000)	(0.0031)	(0.0558)	(0.4636)	(0.1022)	(0.8443)	(0.3845)	(0.7640)	
BSS	−0.1253***	−0.1039***	0.0312**	0.0124	−0.0199	0.0163	0.0062	−0.0084	−0.0097	0.0675***
	(0.0000)	(0.0000)	(0.0233)	(0.3667)	(0.1490)	(0.2375)	(0.6543)	(0.5438)	(0.4789)	(0.0000)

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.
Number of observations = 5280 for the instrumental variables, 5305 for BCD, and 6637 for the rest of the variables.

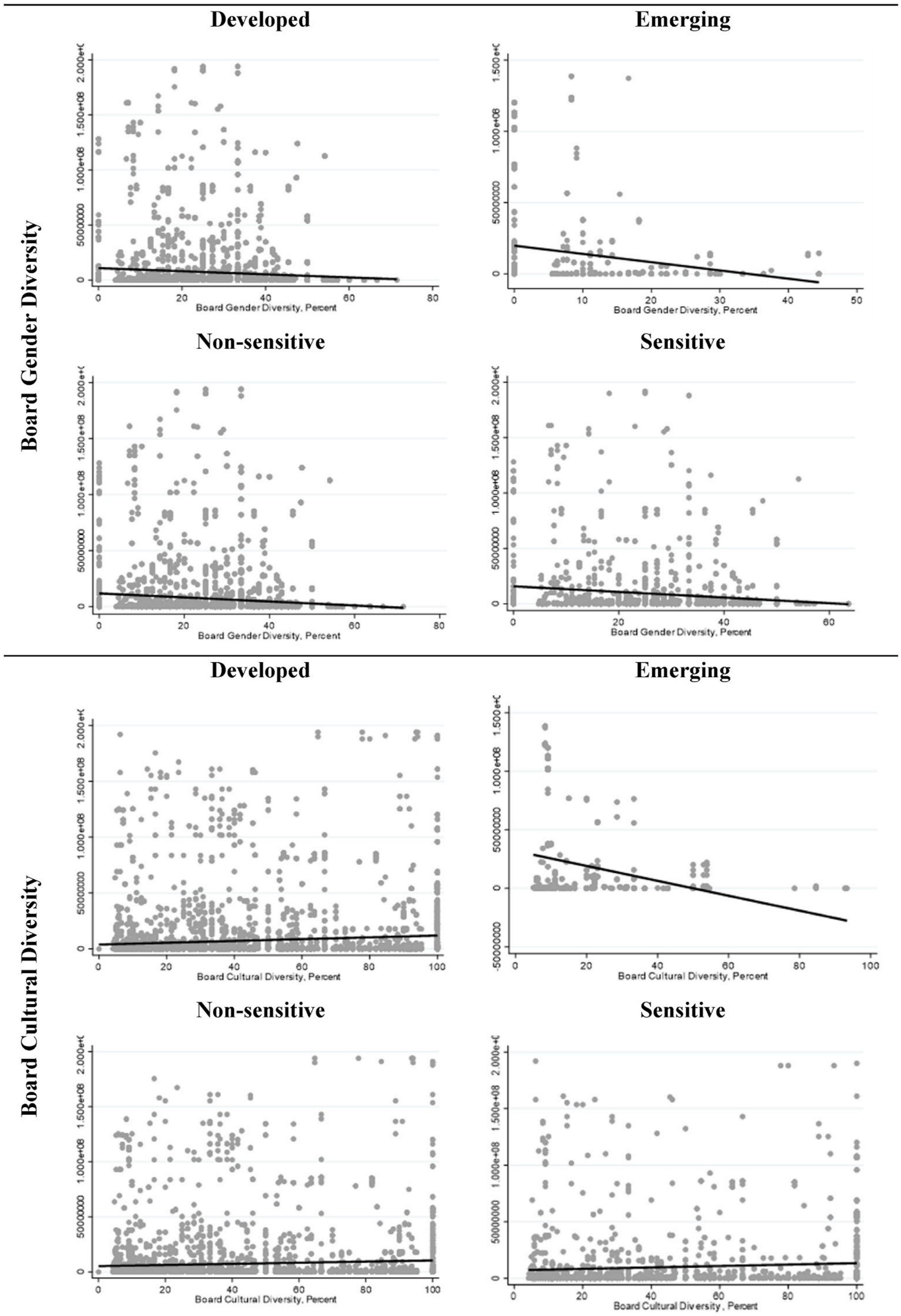

Fig. 1. Scatter graph and fitted values for CO2 emissions.

relationship, although not significant. It is important to note that this sector has the lowest CO2 emissions; thus, a reduction may be more difficult. Hence, the relationship with BGD is also not significant. Therefore, in general terms, the results indicate that Hypothesis 2 also remains confirmed when applied to sectors.

Finally, we conducted a country-by-country analysis of Model 3, considering the seven countries with the largest number of observations in the sample. Table 11 reports the results. Again, both hypotheses are confirmed, although the support for Hypothesis 1 is stronger than that for Hypothesis 2 since the negative relationship between board gender diversity and CO2 emissions is significant in six of the seven individual analyses. In contrast, the positive relationship between board cultural diversity and CO2 emissions is significant in four of the countries analysed.

4.3. Robustness checks

To test the robustness of Model 3, we applied four different strategies. First, fixed-effects estimation with instrumental variables was applied. Six proxy variables were used as instruments to determine

Table 7
Model 1: Ordinary least squares estimation.

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	5.509448*** (0.000)	5.461089*** (0.000)	6.797979*** (0.000)	6.110716*** (0.000)	4.044393*** (0.000)
CO2 (1lag)	0.08413*** (0.000)	0.090069*** (0.000)	−0.023966 (0.591)	0.087605*** (0.000)	0.070552*** (0.000)
BGD	−0.022153*** (0.000)	−0.022934*** (0.000)	−0.034262*** (0.002)	−0.025339*** (0.000)	−0.014803*** (0.001)
MTB	−0.001638 (0.409)	−0.000948 (0.633)	−0.007940 (0.872)	−0.002058 (0.331)	−0.00235 (0.970)
PER	0.000178 (0.204)	0.000169 (0.222)	−0.000025 (0.995)	0.000169 (0.241)	0.000194 (0.731)
ROA	0.007669** (0.042)	0.005553 (0.144)	0.044559** (0.047)	0.008430** (0.039)	0.001226 (0.903)
REV	0.145826*** (0.000)	0.127496*** (0.000)	0.265954*** (0.000)	0.116267*** (0.000)	0.226424*** (0.000)
IND	0.000131 (0.391)	0.000093 (0.546)	0.000195 (0.807)	0.000155 (0.350)	0.000129 (0.748)
PEM	0.903934*** (0.000)	1.253482*** (0.000)	−0.601733 (0.118)	1.160817*** (0.000)	0.254300 (0.282)
TEM	1.090380*** (0.000)	1.033027*** (0.000)	1.385131*** (0.000)	1.125798*** (0.000)	0.958374*** (0.000)
EEI	1.149514*** (0.000)	1.221770*** (0.000)	−0.236725 (0.541)	1.161121*** (0.000)	1.129293*** (0.000)
PEE	0.453545*** (0.000)	0.565613*** (0.000)	−1.120606*** (0.006)	0.253499* (0.077)	0.978873*** (0.000)
BIR	1.979197*** (0.000)	1.958504*** (0.000)	3.432892*** (0.000)	1.983463*** (0.000)	1.984599*** (0.000)
EME	0.486333*** (0.000)			0.466296** (0.013)	0.298585 (0.173)
SES	0.128884** (0.038)	0.124946** (0.048)	0.198965 (0.476)		
Adjusted R^2	0.4446	0.4501	0.4943	0.4431	0.4303
F-statistic	338.09*** (0.000)	352.03*** (0.000)	24.98*** (0.000)	262.32*** (0.000)	95.43*** (0.000)
Sample	5896	5576	320	4270	1626
AIC	25124.64	23599.03	1412.87	18146.70	6970.68
BIC	25224.87	23.691.79	1465.62	18235.73	7046.19

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

Table 8
Model 2: Fixed effects estimation.

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	21.447180*** (0.000)	20.124100*** (0.000)	20.143600** (0.032)	22.191310*** (0.000)	16.68499*** (0.000)
CO2 (1lag)	−0.026771** (0.018)	−0.018131 (0.115)	−0.146836*** (0.004)	−0.0203061 (0.127)	−0.043135** (0.045)
BGD	−0.022655*** (0.000)	−0.023132*** (0.000)	−0.038063*** (0.002)	−0.025327*** (0.000)	−0.016126*** (0.001)
MTB	−0.0041184 (0.183)	−0.0039684 (0.201)	−0.065524 (0.529)	−0.004007 (0.212)	−0.019504 (0.284)
PER	6.68e-06 (0.969)	−5.64e-06 (0.974)	0.002477 (0.592)	7.54e-06 (0.967)	−0.000023 (0.971)
ROA	0.007123** (0.308)	0.003148 (0.660)	0.206161* (0.069)	0.010551 (0.174)	−0.006325 (0.698)
REV	−0.501718*** (0.000)	−0.467833*** (0.000)	−0.206161 (0.592)	−0.552585*** (0.000)	−0.246629 (0.194)
IND	0.000274 (0.262)	0.000277 (0.264)	0.0002814 (0.805)	0.000274 (0.289)	0.000481 (0.530)
PEM	0.915059*** (0.000)	1.178155*** (0.000)	−0.728976* (0.098)	1.061449*** (0.000)	0.484449* (0.065)
TEM	0.979252*** (0.000)	0.936754*** (0.000)	1.126982*** (0.003)	1.014559*** (0.000)	0.847524*** (0.000)
EEI	1.113667*** (0.000)	1.172767*** (0.000)	−0.121118 (0.783)	1.146170*** (0.000)	1.035638*** (0.000)
PEE	0.384865*** (0.004)	0.572034*** (0.000)	−1.227881*** (0.007)	0.258766* (0.096)	0.751239*** (0.006)
BIR	1.914225*** (0.000)	1.876064*** (0.000)	3.665779*** (0.000)	1.917948*** (0.000)	1.917056*** (0.000)
Adjusted R^2	0.4589	0.4501	0.5212	0.4517	0.4555
F-statistic	263.42*** (0.000)	352.03*** (0.000)	18.71*** (0.000)	204.42*** (0.000)	60.71*** (0.000)
Sample	5896	5576	320	4270	1626
Hausman test	699.22*** (0.000)	623.21*** (0.000)	76.70*** (0.000)	446.16*** (0.000)	237.79*** (0.000)
AIC	24002.68	22569.19	1324.81	17395.67	6612.70
BIC	24089.54	22655.33	1373.79	17.478.34	6682.83

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

board gender diversity. The second-stage results are shown in Appendix A (the first stage is omitted for simplicity). The relevance of variables remains stable for the total sample, developed countries and insensitive and sensitive sectors, although in the latter case, the coefficient of board gender diversity is not significant. However, in the case of emerging countries, board cultural diversity is now significant, and board gender diversity changes sign and is no longer significant.

Next, the second-order GMM methodology was implemented, as reflected in Appendix B. The results are confirmed, again showing that the share of women on corporate boards has a negative and significant relationship with CO2 emissions, except in emerging countries, where the relationship is not significant. On the other hand, the relationship between emissions and board cultural diversity is, as in the previous study, positive and significant, except for emerging countries.

Moreover, after predicting board gender diversity with the remaining explanatory variables, the residuals from the prediction were used as a regressor in the final model. The results, included in Appendix C (only the final model is shown, and the estimation of BGD is omitted for simplicity), are similar to those obtained in Model 3, which confirms its validity.

Finally, to reduce the impact of the extreme values of the observations, all variables were winsorised at the 0.01 level, and Model 3 was recalculated. The results, shown in Appendix D, do not diverge from the initial results, again confirming the findings.

5. Discussion

This study confirmed that in European companies included in the MSCI indexes during the period 2010 to 2019, the increased share of women on corporate boards is related with lower CO2 emissions. This relationship holds in both developed and emerging countries and CO2-sensitive and -insensitive sectors. It is also verified in most individual analyses performed by country and by sector of activity.

It is observed that the beta coefficients of the independent variable are larger (in absolute value) for the emerging market sample (see Table 9), which is consistent with the greater slope of the fitted values in Fig. 1. In emerging countries, CO2 emissions are, on average, much higher, so the scope for reduction is greater than in developed countries.

Table 9
Model 3: Fixed effects estimation including board cultural diversity.

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	19.12026*** (0.000)	17.61943*** (0.000)	13.68493 (0.268)	19.42699*** (0.000)	16.46500*** (0.001)
CO2 (1lag)	−0.034102*** (0.009)	−0.024494* (0.062)	−0.170136** (0.026)	−0.035238** (0.022)	−0.031399 (0.199)
BGD	−0.027481*** (0.000)	−0.027476*** (0.000)	−0.062790*** (0.001)	−0.031902*** (0.000)	−0.017235*** (0.002)
BCD	0.007647*** (0.000)	0.007264*** (0.000)	0.019169 (0.148)	0.005523*** (0.000)	0.012739*** (0.000)
MTB	−0.005977 (0.145)	−0.006215 (0.130)	0.050704 (0.681)	−0.005548 (0.194)	−0.021996 (0.249)
PER	0.000081 (0.646)	0.000071 (0.684)	0.002905 (0.529)	0.000042 (0.815)	0.000988 (0.227)
ROA	0.000176 (0.983)	0.001096 (0.894)	−0.007612 (0.837)	0.003529 (0.696)	−0.008096 (0.658)
REV	−0.396653*** (0.000)	−0.357011*** (0.001)	0.087983 (0.861)	−0.413678*** (0.001)	−0.270669 (0.215)
IND	0.000061 (0.857)	0.000111 (0.754)	−0.000395 (0.717)	0.000088 (0.816)	3.26e-06 (0.997)
PEM	0.981918*** (0.000)	1.321176*** (0.000)	−1.527715*** (0.007)	0.985970*** (0.000)	1.060292*** (0.001)
TEM	0.861701*** (0.000)	0.822145*** (0.000)	1.825148*** (0.001)	0.984459*** (0.000)	0.490630*** (0.005)
EEI	1.069314*** (0.000)	1.112292*** (0.000)	0.393609 (0.499)	1.125686*** (0.000)	0.913664*** (0.000)
PEE	0.555313*** (0.001)	0.678854*** (0.000)	−1.006254* (0.092)	0.488579** (0.013)	0.729963** (0.022)
BIR	1.939454*** (0.000)	1.930046*** (0.000)	2.989728*** (0.000)	1.924260*** (0.000)	1.983443*** (0.000)
Adjusted R^2	0.4705	0.4703	0.6043	0.4595	0.4889
F-statistic	190.83*** (0.000)	191.67*** (0.000)	9.32*** (0.000)	144.73*** (0.000)	48.83*** (0.000)
Sample	4690	4489	201	3379	1311
Hausman test	415.92*** (0.000)	357.02*** (0.000)	30.96*** (0.000)	286.73*** (0.000)	86.59*** (0.000)
AIC	18631.23	17777.25	772.84	13459.98	5163.06
BIC	18721.57	17866.98	819.09	13545.74	5235.56

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

In other words, the council's measures can have a broader impact.

In the sectoral analysis, an increased share of women on boards is also linked with lower CO2 emissions in both sensitive and insensitive sectors as a whole. However, the negative relationship is not significant in technology, energy and non-cyclical consumption. One possible explanation could be that the energy sector has the lowest proportion of women on the board of directors, so perhaps its influence has not yet been felt. On the other hand, the technology sector may already be implementing the necessary corrective measures. Indeed, CO2 emissions can be reduced to a certain level beyond which production would no longer be possible. In other words, every industry will have a minimum level of pollution that cannot be avoided with current technological progress and will persist unless there is a breakthrough in scientific knowledge.

Moreover, the analysis applied to seven major EU countries confirms that women on corporate boards are linked with CO2 emissions in six of them. Italy is the exception. Together with France, Italy experienced the largest growth in the share of women on boards between 2007 and 2020, intending to reach the legal quota (Valls Martínez, 2020). This may have meant that the best female candidates were not elected or did not have sufficient influence. It is also likely that Italian legislation on air emissions has some distinguishing features compared to other countries. However, these issues are beyond the scope of this study.

The above results show that companies that incorporate environmental policies are those with the highest CO2 emissions. This apparent contradiction may be due to the fact that the companies begin to implement mitigating measures once their emissions are high, rather than from the outset, as a mechanism to avoid violating legal limits or moral standards imposed by society or pressure groups. Companies with low emission levels do not contravene any standards and are not considered hazardous. However, the danger faced by most polluting companies is twofold: on the one hand, they risk economic or administrative penalties imposed by governments; on the other hand, society's rejection will result in severe economic costs.

Thus, according to legitimacy theory, and to ensure their long-term existence (Fernández-Gago et al., 2018; Scherer and Palazzo, 2007), companies must take the necessary measures to avoid legal and social sanctions, such as policies for reducing emissions, increasing energy efficiency, minimising the negative impact of their activities on biodiversity, etc. Furthermore, gender diversity on company boards reinforces the company's legitimacy in two different aspects: it fulfils the right to equality and non-discrimination for women, considered one of the priority sustainable development goals of the 2030 Agenda (Gennari, 2018), and, according to the results of this study, it also reduces CO2 emissions.

In recent years, following the guidelines of the European Commission, different countries have developed legal regulations to include legislation for the recommendation or obligation to achieve a specific minimum share of women on company boards. This measure has not always been well received, and many voices have cried out against companies being subject to such an obligation, arguing that board members should be appointed based on qualifications and experience, not on the ground of their gender.

This work evidences the advantages of incorporating women into monitoring positions, both for companies and the planet. If shareholders, managers, legislators and society, in general, were aware of this fact, there would be no need for mandatory quotas. However, this mentality is still far from reality. This shortcoming is observed (see Table 2) from differences between the average proportions of women on the board (27.495%) and women executives (13.717%), which, in a large number of cases, are due to the quota laws for the board of directors. This is why this legal obligation is necessary today. It is important to note that only 32.4% of the companies have day-care services. The incorporation of women into the workforce, at all levels of the company, requires measures to reconcile work and family life. As long as women are relegated to caring for the home and family, there can be no effective equality in the workplace. The results of studies such as the present one should become common knowledge and part of the spirit of society. In this way, we will contribute to a more equitable society from a gender standpoint and a healthier one from an environmental perspective.

On the other hand, the few previous research on cultural diversity on company boards and CO2 emissions showed no relationship between the two variables (Haque, 2017) or found a negative relationship. However, our empirical evidence shows a positive association (Varrone et al., 2020); i.e., greater cultural diversity is associated with higher emissions. However, this relationship was not found to be significant in emerging countries and some particular sectors (energy and technology sectors; Germany, Sweden and Italy). Individuals' perception of the effects of cultural diversity is referred to as *diversity beliefs* (Van Dick et al., 2008), which may be different depending on the context under consideration. Thus, in a subjective way, while gender diversity may be perceived as positive for the group, cultural diversity may be perceived as unfavourable, conditioning its effectiveness. It is also possible that foreign

Table 10
Fixed effects estimation by sectors.

Variable	Basic Materials	Consumer Cyclicals	Consumer Non-Cyclic.	Energy	Financials	Healthcare	Industrials	Technology	Telecomm. Services	Utilities
Intercept	4.684999 (0.603)	18.63262*** (0.000)	41.78050*** (0.000)	8.672391 (0.383)	21.78645*** (0.000)	10.30380 (0.201)	21.43811*** (0.001)	18.75581** (0.033)	28.71954 (0.266)	−5.688667 (0.705)
CO2 (1lag)	−0.070304* (0.072)	−0.053263* (0.080)	−0.041721 (0.360)	0.038034 (0.514)	−0.008631 (0.823)	−0.027691 (0.563)	−0.059491** (0.0274)	0.023042 (0.685)	−0.058363 (0.369)	−0.424711 (0.552)
BGD	−0.032378*** (0.000)	−0.040989*** (0.000)	−0.011141 (0.279)	−0.001271 (0.920)	−0.023139*** (0.009)	−0.031188*** (0.001)	−0.033276*** (0.000)	−0.012008 (0.291)	−0.024803* (0.090)	−0.030646* (0.055)
BCD	0.010546*** (0.001)	0.004109* (0.088)	0.010640*** (0.005)	0.015512*** (0.000)	0.003578 (0.259)	0.006590* (0.077)	0.007639*** (0.000)	−0.002153 (0.580)	0.012416** (0.020)	0.017004*** (0.005)
MTB	−0.160794 (0.137)	0.000657 (0.956)	−0.000442 (0.985)	0.000809 (0.981)	−0.008689 (0.485)	0.044494 (0.393)	−0.054219 (0.210)	−0.008502 (0.176)	−0.058267 (0.387)	0.580232* (0.071)
PER	0.001243 (0.144)	0.000239 (0.619)	−0.011211 (0.131)	−0.001454 (0.724)	0.000737 (0.566)	−0.000751 (0.189)	0.000602 (0.283)	−4.30e-06 (0.988)	9.51e-06 (0.979)	0.005347 (0.371)
ROA	0.016765 (0.535)	0.004365 (0.792)	−0.095314** (0.032)	−0.001941 (0.963)	0.019850 (0.408)	−0.025774 (0.319)	0.030007 (0.380)	0.011008 (0.567)	0.030907 (0.507)	−0.157339 (0.157)
REV	0.328956 (0.407)	−0.309706 (0.143)	−1.408429*** (0.001)	0.075793 (0.857)	−0.604453** (0.022)	0.009144 (0.980)	−0.497198* (0.083)	−0.507261 (0.217)	−0.859351 (0.446)	0.692965 (0.295)
IND	0.001297 (0.544)	0.000214 (0.879)	−0.000798 (0.416)	0.0052750 (0.277)	−0.001398 (0.135)	0.000506 (0.816)	0.001395 (0.246)	0.000581 (0.791)	0.004639 (0.126)	−0.002867 (0.569)
PEM	0.336847 (0.547)	0.318864 (0.487)	1.994564*** (0.001)	0.709334 (0.256)	0.458213 (0.262)	1.745511*** (0.001)	1.701308*** (0.000)	1.252577* (0.065)	−0.017023 (0.982)	1.230047 (0.191)
TEM	0.673986** (0.012)	1.258799*** (0.000)	0.065923 (0.849)	0.239147 (0.561)	1.106667*** (0.000)	1.187554*** (0.000)	0.611384*** (0.000)	1.130769*** (0.002)	0.834372* (0.055)	1.383588*** (0.007)
EEI	1.019745*** (0.000)	1.122173*** (0.000)	0.742074*** (0.004)	0.857765*** (0.005)	1.214769*** (0.000)	0.670872** (0.011)	1.091371*** (0.000)	1.633793*** (0.000)	1.178096*** (0.004)	1.332277*** (0.000)
PEE	0.467138 (0.386)	0.039538 (0.929)	1.600616*** (0.008)	−0.174844 (0.796)	1.065173** (0.014)	−0.317594 (0.574)	0.304665 (0.397)	1.261310* (0.066)	2.471862*** (0.002)	−0.664607 (0.492)
BIR	1.994700*** (0.000)	1.867591*** (0.000)	1.844927*** (0.000)	1.933238*** (0.000)	2.006687*** (0.000)	1.879952*** (0.000)	1.986465*** (0.000)	1.710896*** (0.000)	1.654661*** (0.000)	2.230796*** (0.000)
Adj. R^2	0.4855	0.4503	0.4827	0.5067	0.4373	0.4377	0.4473	0.5260	0.5586	0.5225
F-statistic	19.70*** (0.000)	33.82*** (0.0000)	17.59*** (0.0000)	8.46*** (0.0000)	28.75*** (0.0000)	14.82*** (0.0000)	46.69*** (0.0000)	17.92*** (0.0000)	8.79*** (0.0000)	8.57*** (0.0000)
Sample	473	860	406	264	566	373	1105	284	191	168

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

Table 11
Fixed effects estimation by countries.

Variable	UK	Germany	France	Switzerland	Sweden	Italy	Spain
Intercept	16.91095*** (0.000)	15.17303** (0.041)	16.13350* (0.078)	28.97414** (0.024)	18.18626** (0.044)	23.81327 (0.114)	18.87111 (0.314)
CO2 (1lag)	−0.074934*** (0.003)	0.047432 (0.236)	0.013981 (0.707)	−0.009149 (0.841)	−0.031351 (0.466)	−0.079919 (0.297)	−0.100926 (0.202)
BGD	−0.024921*** (0.000)	−0.028151*** (0.002)	−0.030577*** (0.000)	−0.039452*** (0.000)	−0.043382*** (0.000)	−0.010706 (0.523)	−0.035535* (0.069)
BCD	0.008184*** (0.000)	0.000949 (0.774)	0.009841*** (0.000)	0.006531* (0.073)	0.004486 (0.190)	0.007625 (0.208)	0.013589** (0.034)
MTB	−0.005324 (0.314)	0.038921 (0.459)	−0.177602* (0.064)	−0.061274 (0.351)	−0.008539 (0.917)	0.118090 (0.195)	−0.002916 (0.985)
PER	0.000696 (0.425)	0.001023 (0.241)	0.000599 (0.114)	0.000454 (0.612)	0.0007034 (0.264)	0.000075 (0.832)	−0.004171 (0.363)
ROA	0.006458 (0.599)	−0.003494 (0.917)	0.103294** (0.026)	0.069122* (0.084)	−0.009842 (0.832)	−0.172217* (0.072)	−0.087016 (0.286)
REV	−0.304323 (0.100)	−0.284120 (0.387)	−0.243113 (0.551)	−0.883096 (0.126)	−0.346117 (0.344)	−0.611370 (0.381)	−0.278571 (0.746)
IND	0.000111 (0.778)	−0.002025 (0.524)	0.001513 (0.517)	−0.001402 (0.500)	−0.004784 (0.353)	−0.009008* (0.079)	0.003427 (0.542)
PEM	1.354775*** (0.000)	1.410999*** (0.005)	1.031279* (0.064)	1.886361*** (0.007)	1.207899** (0.027)	1.726908** (0.026)	−1.100733 (0.264)
TEM	0.835108*** (0.000)	0.854975*** (0.002)	0.689433*** (0.005)	0.420574 (0.154)	1.022338*** (0.001)	1.090218** (0.013)	2.305026*** (0.000)
EEI	1.147271*** (0.000)	1.324819*** (0.000)	1.043891 (0.000)	0.955992*** (0.000)	1.068020*** (0.000)	1.198759*** (0.002)	0.776946 (0.110)
PEE	0.491018*** (0.119)	0.783947 (0.164)	−0.404067 (0.518)	0.683808 (0.289)	1.530710*** (0.008)	0.689602 (0.363)	−0.022079 (0.981)
BIR	1.884432*** (0.000)	1.794151*** (0.000)	1.800630*** (0.000)	1.979832*** (0.000)	2.238961*** (0.000)	2.214365*** (0.000)	1.740456*** (0.000)
Adjusted R^2	0.4672	0.5108	0.4760	0.4923	0.5044	0.4803	0.4159
F-statistic	55.27*** (0.000)	22.89*** (0.000)	23.69*** (0.000)	18.11*** (0.000)	22.27*** (0.000)	9.89*** (0.0000)	5.35*** (0.0000)
Sample	1238	527	589	386	359	172	170

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

board members are less interested than local ones in protecting the environment where the company is located due to their reduced involvement.

To summarise, this article provides an empirical and theoretically grounded study that contributes to the following United Nations Sustainable Development Goals: (1) gender equality, proclaiming the participation of women in business monitoring and economic decision making at the highest level; (2) health and well-being, reducing the number of illnesses and deaths caused by air pollution; (3) responsible production and consumption through sustainable management that minimises polluting emissions with harmful effects on human health and the environment; (4) climate action, mitigating the adverse effects of industry on climate change by controlling gas emissions; and (5) life of terrestrial ecosystems, contributing to the preservation of flora and fauna through cleaner air.

6. Conclusions

This article analyse the relationship between gender and cultural diversity on company boards and CO2 emissions in companies located in developed and emerging European markets from 2010 to 2019. The findings show that the higher the share of female members on the corporate boards, the lower the CO2 emissions. The reverse is true for cultural diversity. Similarly, the negative effect of a sustainable strategy to reduce emissions on company performance has also been noted. In addition, it also shows how the establishment of measures by companies to mitigate their harmful effects on the environment is primarily aimed at legitimising themselves in the eyes of the state and society.

This article makes a significant contribution to the current literature on gender equality and sustainability: it is the first to study the direct effects of the proportion of women and cultural diversity on corporate boards on CO2 emissions, with a comparative analysis between developed and emerging countries, as well as between sensitive and insensitive sectors. In addition, it is the first work to relate cultural diversity to CO2 emissions from these prisms.

This research provides practical implications for managers, shareholders and policymakers. For managers and shareholders, the results obtained demonstrate the suitability of improving the gender balances on boards of directors. Women bring a different perspective to boards from men, increasing the abilities of the board, which will lead many companies to orientate their strategies more closely towards sustainability and environmental protection (Bernardi and Threadgill, 2010). This ecological awareness will increase the respect and trust of their stakeholders, thereby gaining significant competitive advantages over their competitors (Valls Martínez et al., 2019). This research demonstrates that policymakers should try to improve diversity and equality in companies through legislation and effective campaigns to raise awareness in companies. Public Administrations should carry out effective awareness-raising campaigns and implement incentives aimed at increasing the share of women on companies' boards, thus contributing to the achievement of five sustainable development goals for 2030 established by the United Nations (Carlsson Kanyama et al., 2018): gender equality, good health and well-being, responsible consumption and production, climate action and life on land.

In addition, if cultural diversity is to be promoted and have a positive environmental effect, awareness-raising campaigns should be conducted to promote positive beliefs towards this type of diversity.

This research is not without limitations. First, this study focuses on listed European companies, so the results may not apply to other geographical areas. Therefore, future studies could focus their research on different areas of the world. Second, this research only analyses large companies and ignores unlisted companies and SMEs, which account for the largest number of businesses. Therefore, it would be desirable to expand the sample and consider unlisted companies and SMEs.

Despite the aforementioned limitations, this article has significant value in that it examines a very long time span and analyses both emerging and developed markets by differentiating between sensitive and insensitive sectors and different sectors of activity and countries.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Fixed Effects Estimation with Instrumental Variable. First stage

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	−21.329630* (0.093)	−23.13847* (0.076)	1.692289 (0.976)	−31.781050** (0.029)	5.444988 (0.839)
CO2 (1lag)	−0.015845 (0.819)	−0.050951 (0.472)	−0.908905*** (0.026)	−0.032218 (0.696)	0.061318 (0.635)
BCD	0.001549 (0.780)	0.002909 (0.602)	−0.117409* (0.055)	−0.000431 (0.948)	0.004393 (0.672)
MTB	0.045818** (0.036)	0.041249* (0.062)	0.035779 (0.949)	−0.051363** (0.025)	−0.157714 (0.116)
PER	0.000875 (0.351)	0.000826 (0.379)	0.038041* (0.073)	0.000866 (0.371)	0.000241 (0.955)
ROA	−0.052323 (0.224)	−0.044575 (0.315)	0.012823 (0.938)	−0.037306 (0.442)	−0.119222 (0.217)
REV	1.801485*** (0.001)	1.895826*** (0.001)	−0.068499 (0.976)	2.357802*** (0.001)	0.442119 (0.702)
IND	0.001317 (0.465)	0.002323 (0.223)	−0.004794 (0.334)	0.000995 (0.521)	0.004422 (0.294)
PEM	2.959156*** (0.001)	3.631650*** (0.000)	1.652028 (0.546)	3.107307*** (0.002)	2.978474* (0.075)
TEM	−0.130659 (0.781)	−0.139233 (0.771)	−1.592938 (0.527)	0.034638 (0.949)	−0.706404*** (0.448)
EEI	−3.379575*** (0.000)	−3.391564*** (0.000)	0.680275 (0.807)	−3.374236*** (0.000)	−3.542543*** (0.000)
PEE	−0.202531 (0.822)	0.495883 (0.601)	−6.168799** (0.028)	−0.513953 (0.630)	0.856076 (0.615)
BIR	1.996039*** (0.000)	2.062493*** (0.000)	−6.645483** (0.018)	2.575883*** (0.000)	0.603802 (0.397)
IBM	0.035169*** (0.000)	0.034563*** (0.000)	0.201043*** (0.001)	0.028893*** (0.002)	0.050828*** (0.000)
PBD	1.399069*** (0.001)	1.353179*** (0.002)	1.826328 (0.561)	0.870730* (0.089)	2.850841*** (0.001)
DCS	1.523891*** (0.000)	1.477609*** (0.000)	3.567929 (0.245)	1.304857*** (0.004)	2.021225*** (0.004)
HRP	3.701832*** (0.000)	3.079639*** (0.000)	5.215674*** (0.007)	4.032607*** (0.000)	2.741611* (0.052)
EGD	0.285624*** (0.000)	0.295319*** (0.000)	−0.053872 (0.534)	0.276311*** (0.000)	0.307716*** (0.000)
BSS	−0.068370*** (0.000)	−0.065713*** (0.000)	−0.101094** (0.024)	−0.071733*** (0.000)	−0.055612*** (0.001)
R^2 Within	0.1525	0.1584	0.3746	0.1553	0.1667
F-statistic	37.78*** (0.000)	38.00*** (0.000)	4.19*** (0.000)	27.82*** (0.000)	11.52*** (0.000)
Sample	4671	4470	201	3364	1307
Groups	875	818	57	622	253

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

Appendix A. Fixed Effects Estimation with Instrumental Variable. Second stage

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	18.99079*** (0.000)	17.29965*** (0.000)	17.47635 (0.181)	19.28162*** (0.000)	15.72975*** (0.002)
CO2 (1lag)	−0.034042*** (0.009)	−0.024899* (0.059)	−0.221505*** (0.009)	−0.035266** (0.022)	−0.032112 (0.190)
BGD	−0.023842*** (0.004)	−0.035101*** (0.000)	0.001818 (0.964)	−0.032203*** (0.001)	−0.005021 (0.730)
BCD	0.007611*** (0.000)	0.007158** (0.000)	0.030033** (0.046)	0.005459*** (0.000)	0.012636*** (0.000)
MTB	−0.006366 (0.124)	−0.005967 (0.149)	0.008527 (0.948)	−0.005718 (0.186)	−0.020483 (0.286)
PER	0.000077 (0.661)	0.000076 (0.663)	0.001151 (0.815)	0.000042 (0.818)	0.000959 (0.242)
ROA	0.001128 (0.889)	0.001474 (0.859)	−0.007971 (0.837)	0.004363 (0.632)	−0.006589 (0.720)
REV	−0.395106*** (0.000)	−0.334022*** (0.002)	−0.087916 (0.870)	−0.406963*** (0.001)	−0.251543 (0.251)
IND	0.000068 (0.839)	0.000138 (0.698)	−0.000249 (0.827)	0.000099 (0.793)	−9.40e-06 (0.991)
PEM	0.988712*** (0.000)	1.372178*** (0.000)	−1.538865*** (0.008)	1.011694*** (0.000)	1.023440*** (0.001)
TEM	0.860135*** (0.000)	0.829388*** (0.000)	1.897139*** (0.001)	0.985356*** (0.000)	0.495166*** (0.005)
EEI	1.075599*** (0.000)	1.080493*** (0.000)	0.642086 (0.303)	1.117034*** (0.000)	0.959358*** (0.000)
PEE	0.540068*** (0.001)	0.675424*** (0.000)	−0.659212 (0.311)	0.473211** (0.016)	0.700778** (0.029)
BIR	1.927202*** (0.000)	1.951786*** (0.000)	3.198117*** (0.000)	1.920729*** (0.000)	1.973898*** (0.000)
R^2 within	0.3931	0.4027	0.4293	0.4046	0.3755
Wald chi2	205355.91*** (0.000)	198607.53*** (0.000)	9655.44*** (0.000)	143290.07*** (0.000)	63015.39*** (0.000)
Sample	4671	4470	201	3364	1307
Groups	875	818	57	622	253

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

Appendix B. GMM Estimation

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	22.57046*** (0.000)	21.38253*** (0.000)	26.54746 (0.320)	29.96682*** (0.000)	−1.759011 (0.886)
CO2 (1lag)	0.020739 (0.446)	0.021998 (0.416)	−0.074461 (0.691)	−0.002484 (0.933)	−0.036721 (0.552)
BGD	−0.032180*** (0.000)	−0.031934*** (0.000)	−0.044157 (0.163)	−0.032927*** (0.000)	−0.030980*** (0.000)
BCD	0.005322*** (0.000)	0.005157*** (0.000)	0.017899 (0.394)	0.003075* (0.054)	0.009825*** (0.002)
MTB	−0.006955** (0.037)	−0.007644** (0.018)	−0.031311 (0.834)	−0.007825** (0.032)	−0.019225 (0.686)
PER	0.000231 (0.285)	0.000235 (0.292)	0.003601 (0.418)	0.000165 (0.454)	0.001291 (0.228)
ROA	0.000863 (0.949)	0.001394 (0.916)	0.019482 (0.613)	0.009923 (0.543)	−0.010534 (0.710)

(continued on next page)

(*continued*)

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
REV	−0.561739** (0.018)	−0.535416** (0.024)	−0.509059 (0.628)	−0.896582*** (0.001)	0.497427 (0.343)
IND	−0.000362 (0.379)	−0.000363 (0.405)	0.002294 (0.785)	−0.000373 (0.435)	0.001276 (0.421)
PEM	0.658211** (0.013)	0.980254*** (0.000)	−0.683949 (0.519)	0.593205** (0.040)	1.122047* (0.093)
TEM	0.731089*** (0.000)	0.672391*** (0.000)	2.415112* (0.058)	0.829516*** (0.000)	0.429581 (0.189)
EEI	1.053196*** (0.000)	1.116297*** (0.000)	−1.716273 (0.196)	1.073346*** (0.000)	0.914139*** (0.000)
PEE	0.642365** (0.023)	0.877824*** (0.003)	−1.637128** (0.045)	0.655899** (0.036)	0.705695 (0.289)
BIR	2.076884*** (0.000)	2.032955*** (0.000)	5.458412** (0.017)	1.991667*** (0.000)	2.260710*** (0.000)
Instruments	49	49	38	49	49
Wald chi2	1165.69*** (0.000)	1210.00*** (0.000)	225.92*** (0.000)	855.71*** (0.000)	316.74*** (0.000)
Sample	3175	3084	91	2322	853
Groups	769	729	40	555	214
AR(2)	0.2329 (0.8158)	0.17759 (0.8590)	−0.57191 (0.5674)	0.24113 (0.8095)	0.01701 (0.9864)

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

Appendix C. Fixed Effects Estimation with Residuals

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	19.46355*** (0.000)	18.07239*** (0.000)	17.55459 (0.154)	20.28344*** (0.000)	15.86397*** (0.002)
CO2 (1lag)	−0.033344*** (0.010)	−0.022969* (0.080)	−0.218105*** (0.004)	−0.033647** (0.029)	−0.032267 (0.187)
BGD	−0.027484*** (0.000)	−0.027476*** (0.000)	−0.062790*** (0.001)	−0.031902*** (0.000)	−0.017235*** (0.002)
BCD	0.007822*** (0.000)	0.007426*** (0.000)	0.030116 (0.020)	0.005841*** (0.000)	0.012685*** (0.000)
MTB	−0.007647* (0.062)	−0.007779* (0.058)	0.006141 (0960)	−0.007663* (0.072)	−0.019580 (0.304)
PER	0.000058 (0.742)	0.000051 (0.772)	0.001426 (0.756)	0.000018 (0.920)	0.000950 (0.245)
ROA	0.001868 (0.817)	0.002639 (0.748)	−0.006744 (0.856)	0.005200 (0.565)	−0.006567 (0.720)
REV	−0.443789*** (0.000)	−0.409121*** (0.000)	0.092539 (0.854)	−0.490673*** (0.000)	−0.263140 (0.228)
IND	0.000033 (0.923)	0.000059 (0.868)	−0.000272 (0.803)	0.000051 (0.892)	−0.000030 (0.970)
PEM	0.902271*** (0.000)	1.213916*** (0.000)	−1.540785*** (0.006)	0.883859*** (0.000)	1.014241*** (0.001)
TEM	0.840211*** (0.000)	0.800899*** (0.000)	1.892304*** (0.000)	0.949943*** (0.000)	0.493943*** (0.005)
EEI	1.162672*** (0.000)	1.203971*** (0.000)	0.695331 (0.230)	1.232630*** (0.000)	0.977748*** (0.000)
PEE	0.528754*** (0.002)	0.643435*** (0.000)	−0.688091 (0.242)	0.473964** (0.016)	0.689587** (0.030)
BIR	1.859777*** (0.000)	1.847070*** (0.000)	3.156125*** (0.000)	1.809175*** (0.000)	1.964478*** (0.000)
Adjusted R^2	0.4705	0.4703	0.6043	0.4595	0.4889
F-statistic	190.83*** (0.000)	191.67*** (0.000)	9.32*** (0.000)	144.73*** (0.000)	48.83*** (0.002)
Sample	4690	4489	201	3379	1311

p-value in parentheses.
***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

Appendix D. Model 3: Fixed Effects Estimation with the winsorised variables at the 0.01 level

Variable	All sample	Developed countries	Emerging countries	Non-sensitive sectors	Sensitive sectors
Intercept	19.83549*** (0.000)	18.48448*** (0.000)	17.18347 (0.154)	20.28665*** (0.000)	17.21189*** (0.001)
CO2 (1lag)	−0.032810*** (0.011)	−0.024309* (0.064)	−0.135565* (0.052)	−0.033942** (0.027)	−0.029301 (0.230)
BGD	−0.027100*** (0.000)	−0.027141*** (0.000)	−0.061169*** (0.000)	−0.031474*** (0.000)	−0.016529*** (0.003)
BCD	0.007613*** (0.000)	0.007256*** (0.000)	0.016807 (0.165)	0.005447*** (0.000)	0.012703*** (0.000)
MTB	−0.025994 (0.102)	−0.025775 (0.109)	0.080428 (0.481)	−0.023749 (0.198)	−0.032694 (0.296)
PER	0.000152 (0.909)	0.000284 (0.833)	0.003333 (0.546)	0.000034 (0.983)	0.000666 (0.777)
ROA	0.003691 (0.740)	0.002314 (0.841)	−0.011339 (0.772)	0.011213 (0.395)	−0.011762 (0.573)
REV	−0.424115*** (0.000)	−0.388250*** (0.000)	−0.073816 (0.881)	−0.450150*** (0.000)	−0.296897 (0.179)
IND	0.000548 (0.389)	0.000547 (0.406)	−0.000238 (0.917)	0.000568 (0.439)	0.000554 (0.667)
PEM	0.911308*** (0.000)	1.250151*** (0.000)	−1.600496*** (0.002)	0.919291*** (0.000)	0.981161*** (0.002)
TEM	0.843266*** (0.000)	0.805879*** (0.000)	1.669169*** (0.001)	0.962332*** (0.000)	0.481283*** (0.006)
EEI	1.077130*** (0.000)	1.116204*** (0.000)	0.461184 (0.385)	1.135969*** (0.000)	0.917471*** (0.000)
PEE	0.506789*** (0.002)	0.610412*** (0.000)	−0.956733* (0.079)	0.455701** (0.018)	0.615157** (0.052)
BIR	1.925837*** (0.000)	1.918121*** (0.000)	0.538918*** (0.000)	1.905195*** (0.000)	1.986879*** (0.000)
Adjusted R^2	0.4722	0.4695	0.6495	0.4618	0.4888
F-statistic	191.17*** (0.000)	190.56*** (0.000)	10.55*** (0.000)	145.54*** (0.000)	48.38*** (0.000)
Sample	4690	4489	201	3379	1311

p-value in parentheses.

References

Abbasi, F., Riaz, K., 2016. CO2 emissions and financial development in an emerging economy: an augmented VAR approach. Energy Pol. 90, 102–114. https://doi.org/10.1016/j.enpol.2015.12.017.

Ahmad, N., Amin, S., 2020. Does ethnic polarization stimulate or relegate trade and environmental performance? A global perspective. Environ. Dev. Sustain. 22 (7), 6513–6536. https://doi.org/10.1007/s10668-019-00497-z.

Al-Qahtani, M., Elgharbawy, A., 2020. The effect of board diversity on disclosure and management of greenhouse gas information: evidence from the United Kingdom. J. Enterprise Inf. Manag. 33 (6), 1557–1579. https://doi.org/10.1108/JEIM-08-2019-0247.

Al-Shaer, H., Zaman, M., 2016. Board gender diversity and sustainability reporting quality. J. Contemp. Account. Econ. 12 (3), 210–222. https://doi.org/10.1016/j.jcae.2016.09.001.

Amin, S., Ahmad, N., Iqbal, A., Mustafa, G., 2021. Asymmetric analysis of environment, ethnic diversity, and international trade nexus: empirical evidence from Pakistan. Environ. Dev. Sustain. 23 (8), 12527–12549. https://doi.org/10.1007/s10668-020-01181-3.

Arellano, M., Bover, O., 1995. Another look at the instrumental variable estimation of error-components models. J. Econom. 68 (1), 29–51. https://doi.org/10.1016/0304-4076(94)01642-D.
Aslam, S., Abdul, M., Makki, M., Mahmood, S., Amin, S., 2018. Gender diversity and managerial ownership response to corporate social responsibility initiatives: empirical evidence from Australia. J. Manage. Sci. 12 (2), 131–151.
Bear, S., Rahman, N., Post, C., 2010. The impact of board diversity and gender composition on corporate social responsibility and firm reputation. J. Bus. Ethics 97 (2), 207–221. https://doi.org/10.1007/s10551-010-0505-2.
Beji, R., Yousfi, O., Loukil, N., Omri, A., 2021. Board diversity and corporate social responsibility: empirical evidence from France. J. Bus. Ethics 173 (1), 133–155. https://doi.org/10.1007/s10551-020-04522-4.
Ben-Amar, W., Chang, M., McIlkenny, P., 2017. Board gender diversity and corporate response to sustainability initiatives: evidence from the carbon disclosure project. J. Bus. Ethics 142 (2), 369–383. https://doi.org/10.1007/s10551-015-2759-1.
Bernardi, R., Threadgill, V., 2010. Women directors and corporate social responsibility. EJBO : Electron. J. Bus. Ethics Organ. Stud. 15 (2), 15–21.
Berrone, P., Cruz, C., Gomez-Mejia, L.R., Larraza-Kintana, M., 2010. Socioemotional wealth and corporate responses to institutional pressures: do family-controlled firms pollute less? Adm. Sci. Q. 55 (1), 82–113.
Boulouta, I., 2013. Hidden connections: the link between board gender diversity and corporate social performance. J. Bus. Ethics 113, 185–197. https://doi.org/10.1007/s10551-012-1293-7.
Burkhardt, K., Nguyen, P., Poincelot, E., 2020. Agents of change: women in top management and corporate environmental performance. Coporate Soc. Disclosure. Environ. Manage. 27 (4), 1591–1604. https://doi.org/10.1002/csr.1907.
Campbell, J.L., 2006. Institutional analysis and the paradox of corporate social responsibility. Am. Behav. Sci. 49 (7), 925–938. https://doi.org/10.1177/0002764205285172.
Campbell, K., Mínguez-Vera, A., 2008. Gender diversity in the boardroom and firm financial performance. J. Bus. Ethics 83 (3), 435–451. https://doi.org/10.1007/s10551-007-9630-y.
Cao, J., Ellis, K.M., Li, M., 2019. Inside the board room: the influence of nationality and cultural diversity on cross-border merger and acquisition outcomes. Rev. Quant. Finance Account. 53 (4), 1031–1068. https://doi.org/10.1007/s11156-018-0774-x.
Carlsson Kanyama, A., Carlsson Kanyama, K., Wester, M., Snickare, L., Söderberg, I.-L., 2018. Climate change mitigation efforts among transportation and manufacturing companies: the current state of efforts in Sweden according to available documentation. J. Clean. Prod. 196, 588–593. https://doi.org/10.1016/j.jclepro.2018.06.007.
Carter, D.A., D'Souza, F., Simkins, B.J., Simpson, W.G., 2010. The gender and ethnic diversity of US boards and board committees and firm financial performance. Corp. Govern. Int. Rev. 18 (5), 396–414. https://doi.org/10.1111/j.1467-8683.2010.00809.x.
Charumathi, B., Rahman, H., 2019. Do women on boards influence climate change disclosures to CDP? - evidence from large indian companies. Australia Account. Business. Finance. J. 13 (2), 5–31. https://doi.org/10.14453/aabfj.v13i2.2.
Chodorow, N., 1978. The reproduction of mothering. University of California Press. https://doi.org/10.1525/9780520924086.
Choi, H.J., Park, J.-H., 2014. The relationship between learning transfer climates and innovation in public and private organizations in Korea. Int. J. Manpow. 35 (7), 956–972. https://doi.org/10.1108/IJM-07-2012-0101.
Commission, E., 2020. Paris Agreement | Climate Action.
Demb, A., Neubauer, F.-F., 1992. The corporate board: confronting the paradoxes. Long. Range Plan. 25 (3), 9–20.
Dienes, D., Velte, P., 2016. The impact of supervisory board composition on CSR reporting. Evidence from the German two-tier system. Sustainability 8 (1), 1–20. https://doi.org/10.3390/su8010063.
Diez-Cañamero, B., Bishara, T., Otegi-Olaso, J.R., Minguez, R., Fernández, J.M., 2020. Measurement of corporate social responsibility: a review of corporate sustainability indexes, rankings and ratings. Sustainability 12 (5), 1–36. https://doi.org/10.3390/su12052153.
Eagly, A.H., Johannesen-Schmidt, M.C., Van Engen, M.L., 2003. Transformational, transactional, and laissez-faire leadership styles: a meta-analysis comparing women and men. Psychol. Bull. 129 (4), 569–591. https://doi.org/10.1037/0033-2909.129.4.569.
Elsayih, J., Tang, Q., Lan, Y.C., 2018. Corporate governance and carbon transparency: Australian experience. Account. Res. J. 31 (3), 405–422. https://doi.org/10.1108/ARJ-12-2015-0153.
Erhardt, N.L., Werbel, J.D., Shrader, C.B., 2003. Board of director diversity and firm financial performance. Corp. Govern. Int. Rev. 11 (2), 102–111. https://doi.org/10.1111/1467-8683.00011.
Fauver, L., McDonald, M.B., Taboada, A.G., 2018. Does it pay to treat employees well? International evidence on the value of employee-friendly culture. J. Corp. Finance 50, 84–108. https://doi.org/10.1016/j.jcorpfin.2018.02.003.
Fernández-Gago, R., Cabeza-García, L., Nieto, M., 2018. Independent directors' background and CSR disclosure. Corp. Soc. Responsib. Environ. Manag. 25 (5), 991–1001. https://doi.org/10.1002/csr.1515.
Fox, J., Monette, G., 1992. Generalized collinearity diagnostics. J. Am. Stat. Assoc. 87 (417), 178–183. https://doi.org/10.1080/01621459.1992.10475190.
Francoeur, C., Labelle, R., Balti, S., El Bouzaidi, S., 2019. To what extent do gender diverse boards enhance corporate social performance? J. Bus. Ethics 155, 343–357. https://doi.org/10.1007/s10551-017-3529-z.
Freeman, R.E., 1984. Strategic Management: A Stakeholder Approach. Pitman.
Frijns, B., Dodd, O., Cimerova, H., 2016. The impact of cultural diversity in corporate boards on firm performance. J. Corp. Finance 41, 521–541. https://doi.org/10.1016/j.jcorpfin.2016.07.014.
Fuente, J.A., García-Sanchez, I.M., Lozano, M.B., 2017. The role of the board of directors in the adoption of GRI guidelines for the disclosure of CSR information. J. Clean. Prod. 141, 737–750. https://doi.org/10.1016/j.jclepro.2016.09.155.
Furlotti, K., Mazza, T., Tibiletti, V., Triani, S., 2019. Women in top positions on boards of directors: gender policies disclosed in Italian sustainability reporting. Corp. Soc. Responsib. Environ. Manag. 26 (1), 57–70. https://doi.org/10.1002/csr.1657.
Garcia-Castro, R., Ariño, M.A., Canela, M.A., 2010. Does social performance really lead to financial performance? Accounting for endogeneity. J. Bus. Ethics 92 (1), 107–126. https://doi.org/10.1007/s10551-009-0143-8.
García Martín, C.J., Herrero, B., 2020. Do board characteristics affect environmental performance? A study of EU firms. Corp. Soc. Responsib. Environ. Manag. 27 (1), 74–94. https://doi.org/10.1002/csr.1775.
Gennari, F., 2018. Gender balance on boards and corporate sustainability for the 2030 Agenda. Afr. J. Bus. Manag. 12 (11), 343–356. https://doi.org/10.5897/ajbm2018.8553.
Giannarakis, G., Konteos, G., Sariannidis, N., 2014. Financial, governance and environmental determinants of corporate social responsible disclosure. Manag. Decis. 52 (10), 1928–1951. https://doi.org/10.1108/MD-05-2014-0296.
Giannarakis, Grigoris, 2014. Corporate governance and financial characteristic effects on the extent of corporate social responsibility disclosure. Soc. Responsib. J. 10 (4), 569–590. https://doi.org/10.1108/SRJ-02-2013-0008.
Gul, F.A., Srinidhi, B., Ng, A.C., 2011. Does board gender diversity improve the informativeness of stock prices? J. Account. Econ. 51 (3), 314–338. https://doi.org/10.1016/j.jacceco.2011.01.005.
Haque, F., 2017. The effects of board characteristics and sustainable compensation policy on carbon performance of UK firms. Br. Account. Rev. 49 (3), 347–364. https://doi.org/10.1016/j.bar.2017.01.001.
Hill, C.W.L., Jones, T.M., 1992. Stakeholder-agency theory. J. Manag. Stud. 29 (2), 131–154. https://doi.org/10.1111/j.1467-6486.1992.tb00657.x.
Hillman, A.J., Shropshire, C., Cannella, A.A., 2007. Organizational predictors of women on corporate boards. Acad. Manag. J. 50 (4), 941–952. https://doi.org/10.5465/amj.2007.26279222.
Hollindale, J., Kent, P., Routledge, J., Chapple, L., 2019. Women on boards and greenhouse gas emission disclosures. Account. Finance 59 (1), 277–308. https://doi.org/10.1111/acfi.12258.
Hossain, M., Al Farooque, O., Momin, M.A., Almotairy, O., 2017. Women in the boardroom and their impact on climate change related disclosure. Soc. Responsib. J. 13 (4), 828–855. https://doi.org/10.1108/SRJ-11-2016-0208.
Hu, M., Li, R., You, W., Liu, Y., Lee, C.-C., 2020. Spatiotemporal evolution of decoupling and driving forces of CO2 emissions on economic growth along the Belt and Road. J. Clean. Prod. 277, 123272 https://doi.org/10.1016/j.jclepro.2020.123272.
Ibrahim, A.H., Hanefah, M.M., 2016. Board diversity and corporate social responsibility in Jordan. J. Financ. Report. Account. 14 (2), 279–298. https://doi.org/10.1108/JFRA-06-2015-0065.
Ibrahim, N., Angelidis, J., Tomic, I.M., 2009. Managers' attitudes toward codes of ethics: are there gender differences? J. Bus. Ethics 90 (S3), 343–353. https://doi.org/10.1007/s10551-010-0428-y.
Jain, M., Sharma, G.D., Srivastava, M., 2019. Can sustainable investment yield better financial returns: a comparative study of ESG indices and MSCI indices. Risks 7 (1), 1–18. https://doi.org/10.3390/risks7010015.
Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: managerial behavior, agency costs, and ownership structure. J. Financ. Econ. 3 (4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X.
Joecks, J., Pull, K., Vetter, K., 2013. Women on boards and firm performance: what exactly constitutes a "critical mass". J. Bus. Ethics 118 (1), 61–72. https://doi.org/10.2139/ssrn.2009234.
Kassinis, G., Panayiotou, A., Dimou, A., Katsifaraki, G., 2016. Gender and environmental sustainability: a longitudinal analysis. Corp. Soc. Responsib. Environ. Manag. 23 (6), 399–412. https://doi.org/10.1002/csr.1386.
Kılıç, M., Kuzey, C., 2019. The effect of corporate governance on carbon emission disclosures: evidence from Turkey. Int. J. Climate. Strat Manage. 11 (1), 35–53. https://doi.org/10.1108/IJCCSM-07-2017-0144.
Kutan, A.M., Paramati, S.R., Ummalla, M., Zakari, A., 2018. Financing renewable energy projects in major emerging market economies: evidence in the perspective of sustainable economic development. Emerg. Mark. Finance Trade 54 (8), 1761–1777. https://doi.org/10.1080/1540496X.2017.1363036.
Kyaw, K., Olugbode, M., Petracci, B., 2017. Can board gender diversity promote corporate social performance? Coporate. Governance Int. J. Business. Soc. 17 (5), 789–802. https://doi.org/10.1108/CG-09-2016-0183.
Lanoie, P., Laplante, B., Roy, M., 1998. Can capital markets create incentives for pollution control? Ecol. Econ. 26 (1), 31–41. https://doi.org/10.1016/S0921-8009(97)00057-8.
Liang, H., Renneboog, L., 2017. On the foundations of corporate social responsibility. J. Finance 72 (2), 853–910. https://doi.org/10.1111/jofi.12487.
Liao, L., Luo, L., Tang, Q., 2015. Gender diversity, board independence, environmental committee and greenhouse gas disclosure. Br. Account. Rev. 47 (4), 409–424. https://doi.org/10.1016/j.bar.2014.01.002.
Liao, Z., Zhang, M., Wang, X., 2019. Do female directors influence firms' environmental innovation? The moderating role of ownership type. Corp. Soc. Responsib. Environ. Manag. 26 (1), 257–263. https://doi.org/10.1002/csr.1677.
Lin, W.L., Ho, J.A., Sambasivan, M., 2018. Impact of corporate political activity on the relationship between corporate social responsibility and financial performance: a

dynamic panel data approach. Sustainability 11 (1), 1–22. https://doi.org/10.3390/su11010060.
Liu, C., 2018. Are women greener? Corporate gender diversity and environmental violations. J. Corp. Finance 52, 118–142. https://doi.org/10.1016/j.jcorpfin.2018.08.004.
Lopatta, K., Buchholz, F., Kaspereit, T., 2016. Asymmetric information and corporate social responsibility. Bus. Soc. 55 (3), 458–488. https://doi.org/10.1177/0007650315575488.
Luo, L., Tang, Q., Lan, Y-C., 2013. Comparison of propensity for carbon disclosure between developing and developed countries. Account. Res. J. 26 (1), 6–34. https://doi.org/10.1108/ARJ-04-2012-0024.
Martínez-Ferrero, J., Lozano, M.B., Vivas, M., 2021. The impact of board cultural diversity on a firm's commitment toward the sustainability issues of emerging countries: the mediating effect of a CSR committee. Corp. Soc. Responsib. Environ. Manag. 28 (2), 675–685. https://doi.org/10.1002/csr.2080.
Mason, C., Simmons, J., 2014. Embedding corporate social responsibility in corporate governance: a stakeholder systems approach. J. Bus. Ethics 119 (1), 77–86. https://doi.org/10.1007/s10551-012-1615-9.
Masulis, R.W., Wang, C., Xie, F., 2012. Globalizing the boardroom—the effects of foreign directors on corporate governance and firm performance. J. Account. Econ. 53 (3), 527–554. https://doi.org/10.1016/j.jacceco.2011.12.003.
Mateos del Cabo, R., Gimeno, R., Escot, L., 2010. Disentangling discrimination on Spanish boards of directors. Corp. Govern. Int. Rev. 19 (1), 77–95. https://doi.org/10.1111/j.1467-8683.2010.00837.x.
Miller, T., Triana, M.C., 2009. Demographic diversity in the boardroom: mediators of the board diversity–firm performance relationship. J. Manag. Stud. 46 (5), 755–786. https://doi.org/10.1111/j.1467-6486.2009.00839.x.
Miralles-Quiros, M.M., Miralles-Quiros, J.L., Guia Arraiano, I., 2017. Are firms that contribute to sustainable development valued by investors? Corp. Soc. Responsib. Environ. Manag. 24 (1), 71–84. https://doi.org/10.1002/csr.1392.
Moore, G., 2001. Corporate social and financial performance: an investigation in the U.K. Supermarket industry. J. Bus. Ethics 34 (3–4), 299–315. https://doi.org/10.1023/A:1012537016969.
Müller, V.-O., 2014. The impact of board composition on the financial performance of FTSE100 constituents. Proc. Soc. Behave. Sci. 109, 969–975. https://doi.org/10.1016/j.sbspro.2013.12.573.
Nielsen, S., Huse, M., 2010. The contribution of women on boards of directors: going beyond the surface. Corp. Govern. Int. Rev. 18 (2), 136–148. https://doi.org/10.1111/j.1467-8683.2010.00784.x.
Nollet, J., Filis, G., Mitrokostas, E., 2016. Corporate social responsibility and financial performance: a non-linear and disaggregated approach. Econ. Modell. 52 (Part B), 400–407. https://doi.org/10.1016/j.econmod.2015.09.019.
Nuber, C., Velte, P., 2021. Board gender diversity and carbon emissions: European evidence on curvilinear relationships and critical mass. Bus. Strat. Environ. 30 (4), 1958–1992. https://doi.org/10.1002/bse.2727.
O'donovan, G., 2002. Environmental disclosures in the annual report: extending the applicability and predictive power of legitimacy theory. Account Audit. Account. J. 15 (3), 344–371. https://doi.org/10.1108/09513570210435870.
Oliver, C., 1991. Strategic responses to institutional processes. Acad. Manag. Rev. 16 (1), 145–179. https://doi.org/10.5465/amr.1991.4279002.
Orlitzky, M., Bejamin, J.D., 2001. Corporate social performance and firm risk: a meta-analytic review. Bus. Soc. 40 (4), 369–396. https://doi.org/10.1177/000765030104000402.
Paramati, S.R., Alam, M.S., Apergis, N., 2018. The role of stock markets on environmental degradation: a comparative study of developed and emerging market economies across the globe. Emerg. Mark. Rev. 35, 19–30. https://doi.org/10.1016/j.ememar.2017.12.004.
Paramati, S.R., Mo, D., Gupta, R., 2017. The effects of stock market growth and renewable energy use on CO2 emissions: evidence from G20 countries. Energy Econ. 66, 360–371. https://doi.org/10.1016/j.eneco.2017.06.025.
Peillex, J., Boubaker, S., Comyns, B., 2021. Does it pay to invest in Japanese women? Evidence from the MSCI Japan empowering women index. J. Bus. Ethics 170 (3), 595–613. https://doi.org/10.1007/s10551-019-04373-8.
Pfeffer, J., 1973. Size, composition, and function of hospital boards of directors: a study of organization-environment linkage. Adm. Sci. Q. 18 (3), 349–364. https://doi.org/10.2307/2391668.
Prado-Lorenzo, J.M., Garcia-Sanchez, I.M., 2010. The role of the board of directors in disseminating relevant information on greenhouse gases. J. Bus. Ethics 97 (3), 391–424. https://doi.org/10.1007/s10551-010-0515-0.
Prado-Lorenzo, J.M., García-Sánchez, I.M., Gallego-Álvarez, I., 2012. Effects of activist shareholding on corporate social responsibility reporting practices: an empirical study in Spain. J. Economic Finance. Admin. Sci. 17 (32), 7–16.
Rao, K., Tilt, C., 2016. Board diversity and CSR reporting: an Australian study. Meditari Account. Res. 24 (2), 182–210. https://doi.org/10.1108/MEDAR-08-2015-0052.
Reguera-Alvarado, N., de Fuentes, P., Laffarga, J., 2017. Does board gender diversity influence financial performance? Evidence from Spain. J. Bus. Ethics 141 (2), 337–350. https://doi.org/10.1007/s10551-015-2735-9.
Reverte, C., 2009. Determinants of corporate social responsibility disclosure ratings by Spanish listed firms. J. Bus. Ethics 88 (2), 351–366. https://doi.org/10.1007/s10551-008-9968-9.
Sadorsky, P., 2011. Financial development and energy consumption in Central and Eastern European frontier economies. Energy Pol. 39 (2), 999–1006.
Santos-Jaén, J.M., Madrid-Guijarro, A., García-Pérez-de-Lema, D., 2021. The Impact of Corporate Social Responsibility on Innovation in Small and Medium-Sized Enterprises : the Mediating Role of Debt Terms and Human Capital, pp. 1–16. https://doi.org/10.1002/csr.2125.
Scherer, A.G., Palazzo, G., 2007. Towards a political conception of corporate responsibility. Acad. Manag. Rev. 32 (4), 1096–1120. https://doi.org/10.5465/amr.2007.26585837.
Shahbaz, M., Tiwari, A.K., Nasir, M., 2013. The effects of financial development, economic growth, coal consumption and trade openness on CO2 emissions in South Africa. Energy Pol. 61, 1452–1459.
Shankman, N.A., 1999. Reframing the debate between agency and stakeholder theories of the firm. J. Bus. Ethics 19 (4), 319–334. https://doi.org/10.1023/A:1005880031427.
Sial, M.S., Zheng, C., Cherian, J., Gulzar, M.A., Thu, P.A., Khan, T., Khuong, N.V., 2018. Does corporate social responsibility mediate the relation between boardroom gender diversity and firm performance of Chinese listed companies? Sustainability 10 (10), 1–18. https://doi.org/10.3390/su10103591.
Tamazian, A., Chousa, J.P., Vadlamannati, K.C., 2009. Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. Energy Pol. 37 (1), 246–253.
Tingbani, I., Chithambo, L., Tauringana, V., Papanikolaou, N., 2020. Board gender diversity, environmental committee and greenhouse gas voluntary disclosures. Bus. Strat. Environ. 29 (6), 2194–2210. https://doi.org/10.1002/bse.2495.
Upadhyay, A., Zeng, H., 2014. Gender and ethnic diversity on boards and corporate information environment. J. Bus. Res. 67 (11), 2456–2463. https://doi.org/10.1016/j.jbusres.2014.03.005.
Valls Martínez, M.C., 2020. Equality pays: the economic and social benefits of women on boards. Board Agenda. http://www.circulodedirectores.org/2020/08/17/equality-pays-the-economic-and-social-benefits-of-women-on-boards/.
Valls Martínez, M.C., Cruz Rambaud, S., 2019. Women on corporate boards and firm's financial performance. Wom. Stud. Int. Forum 76 (102251), 1–11. https://doi.org/10.1016/j.wsif.2019.102251.
Valls Martínez, M.C., Cruz Rambaud, S., Parra Oller, I.M., 2019. Gender policies on board of directors and sustainable development. Corp. Soc. Responsib. Environ. Manag. 26 (6), 1539–1553. https://doi.org/10.1002/csr.1825.
Valls Martínez, M.C., Martín Cervantes, P.A., Cruz Rambaud, S., 2020. Women on corporate boards and sustainable development in the American and European markets: is there a limit to gender policies? Corp. Soc. Responsib. Environ. Manag. 27 (6), 2642–2656. https://doi.org/10.1002/csr.1989.
Van Dick, R., Van Knippenberg, D., Hägele, S., Guillaume, Y.R.F., Brodbeck, F.C., 2008. Group diversity and group identification: the moderating role of diversity beliefs. Hum. Relat. 61 (10), 1463–1492. https://doi.org/10.1177/0018726708095711.
Varrone, N., D'Angelo, E.D., Gangi, F., Daniele, L.M., 2020. Does cultural diversity of board of directors affect corporate environmental performance? Evidence from the energy sector. Europe Sci. J. ESJ. 16 (28) https://doi.org/10.19044/esj.2020.v16n28p287.
Walls, J.L., Berrone, P., Phan, P.H., 2012. Corporate governance and environmental performance: is there really a link? Strat. Manag. J. 33, 885–913. https://doi.org/10.1002/smj.1952.
Wicker, P., Becken, S., 2013. Conscientious vs. ambivalent consumers: do concerns about energy availability and climate change influence consumer behaviour? Ecol. Econ. 88, 41–48. https://doi.org/10.1016/j.ecolecon.2013.01.005.
Xiao, C., McCright, A.M., 2015. Gender differences in environmental concern: revisiting the institutional trust hypothesis in the USA. Environ. Behav. 47 (1), 17–37. https://doi.org/10.1177/0013916513491571.
Yarram, S.R., Adapa, S., 2021. Board gender diversity and corporate social responsibility: is there a case for critical mass? J. Clean. Prod. 278, 123319 https://doi.org/10.1016/j.jclepro.2020.123319.
Zaid, M.A.A., Wang, M., Abuhijleh, S.T.F., 2019. The effect of corporate governance practices on corporate social responsibility disclosure. J. Global Response. 10 (2), 134–160. https://doi.org/10.1108/JGR-10-2018-0053.
Zaid, M.A.A., Wang, M., Adib, M., Sahyouni, A., T. F. Abuhijleh, S., 2020. Boardroom nationality and gender diversity: implications for corporate sustainability performance. J. Clean. Prod. 251, 119652 https://doi.org/10.1016/j.jclepro.2019.119652.
Zhang, J.Q., Zhu, H., Ding, H., 2013. Board composition and corporate social responsibility: an empirical investigation in the post sarbanes-oxley era. J. Bus. Ethics 114 (3), 381–392. https://doi.org/10.1007/s10551-012-1352-0.
Zhang, Y.-J., 2011. The impact of financial development on carbon emissions: an empirical analysis in China. Energy Pol. 39 (4), 2197–2203. https://doi.org/10.1016/j.enpol.2011.02.026.