Cultural Diversity Effect onto CO_2 Emissions: Evidence from Developed and Emerging Markets

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***Abstract*—In today's world where greenhouse gas emissions are severe and pose a serious threat to human production and life, it is necessary to conduct in-depth research on them. At the same time, gender differences and cultural differences within different organizations also play a crucial role; However, more research is still needed to determine their role in reducing carbon dioxide emissions. In view of this, this project intends to take the major and emerging economies in Europe from 2012 to 2022 as the research objects, and use OLS regression models to test the influence of gender differences and organizational culture differences on CO_2 emissions. Research has found that there is a certain correlation between a higher percentage of female directors and a reduction in CO_2 emissions, but the increase in ethnic diversity has the opposite effect. This study provides strong experimental evidence for the clinical application of IM. This project will provide scientific basis for implementing gender equality and sustainable environmental development strategies, and has significant theoretical and practical significance.**

***Index Terms*—gender diversity, corporate boards, CO_2 emissions, cultural diversity.**

I. Introduction

In the past decade, the swift economic growth has global significantly impacted the environment the most important reason is the emission of carbon dioxide (CO_2). How to coordinate human survival and environmental harmony is a hot topic of global concern (Disli et al., 2016). The US government announced its return to the Paris Agreement in early 2021, calling for more support for environmental protection. In addition, the Paris Agreement also mentions the importance of non-state actors, so local governments play a crucial role in the entire country's emission reduction efforts (Matsumoto et al., 2019). In order to address this issue, financial institutions and non-profit organizations have continuously increased their emphasis on environmental behavior, and companies have also included environmental behavior in their evaluations (Otani and Yamada, 2019).

To enhance the environmental performance of enterprises and enhance their social reputation, many enterprises have invested in their sustainable development activities. However, we must point out that not every enterprise can shoulder social responsibility and make the right decisions. The research results show that the environmental protection concept of enterprises is related to factors such as equity structure, gender, cultural background, etc. This project intends to adopt the theory of pluralism (Cumming et al., 2015), and the study found that there are two significant gender differences in listed companies in China, namely: in enterprises, female directors have greater discourse power and can propose more environmental protection measures, thereby promoting the development of the enterprise . Previous studies have mainly focused on whether gender differences in companies positively influence their social responsibility and environmental effectiveness. Hofstede et al. (2010) argue that compared to material success, women place greater emphasis on life quality, and compared to men, women are more concerned with long-term, autonomous advantages, and altruistic behavior, while men are more concerned with the performance of businesses (Andreoni and Vesterlund, 2001; Silverman, 2003); Taejeson et al. (2009)

Another view is that the governing board should strike equilibrium between shareholders and additional interested parties (Collier, 2008). Nadeem et al. (2020) found that gender differences within corporate boards positively influences the environmental stakeholders of the company. This project proposes that relatived to male board members, female board members are more socially conscious and can enhance corporate social responsibility by coordinating the interests of various stakeholders (Galbreth, 2016). However, the results of other studies are not consistent. Some scholars believe that the influence of female board members in promoting environmental protection is very limited (Galbreth, 2011; Hayes, 2001). Campopiano et al. (2023) also questioned these hypotheses and viewed them as a stereotype that the functioning of the governing board is tightly connected to its social environment. Glass et al. (2016) found that this positive correlation is highly sensitive to certain situations. For example, Nadeem et al. (2020) have recognized that this impact only exists in family businesses. Walls et al. (2012) also confirmed that gender differences have a slightly adverse impact on environmental concerns in industrial enterprises.

At the cultural level, Post et al. (2011) argue that the greater the variety among board members, the broader the perspective of external directors, and the better their decision-making on environmental issues. Prior studies have investigated how board cultural diversity affects their environmental conduct, such as CO_2 emissions, from different perspectives. 2015 Cuadrado Ballesteros et al; Gordon and Zajak, 2001; In 2000, Westphal and Milton. However, the conclusion drawn from this is quite complex.

This problem cannot be summarized. Kang et al. (2019) argue that the nationality, education level, and geographical location of external directors have varying degrees of moderation on the level of corporate social responsibility participation.

This study suggests that existing studies either use dummy variables to measure corporate carbon emissions, or directly use public data to characterize the degree of corporate response to carbon information disclosure through dummy variables. In 2017, Ben Amar et al ; Gallego-Alvarez and Rodriguez Dominguez (2023). This project reflects the response of the enterprise to sustainable development by the

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overall CO_2 emissions and CO_2 equivalent emissions, which is a supplement to harmful substances such as SO2 and heavy metals in traditional environments.

In addition, existing research has mainly focused on corporate social responsibility reporting, disclosure, and company rating (Post et al, 2011). However, there are significant differences in the results of the available studies, mainly due to the fact that this relationship is regulated by multiple contextual variables and has endogeneity; Meanwhile, existing studies have not clearly distinguished the types of corporate social responsibility. At present, there is little literature on the complex organizational issue of how gender and cultural differences affect the governing board, focusing only on CO_2 emissions. On this basis, this project plans to adopt two independent empirical research and industry research methods to examine the differences in carbon reduction between developed and emerging economies, the differences in industries with lower sensitivity to CO_2 . The main research content of this article includes: (1) studying the influence of the proportion of female board members in enterprises on their CO_2 emissions. (2) Study the influence of board culture diversity on a company's CO_2 emissions.

The research results of this project will help to reveal the mechanism by which gender differences and corporate culture differences affect the corporate environment and sustainable development, and provide theoretical basis for enterprises to formulate effective gender difference management strategies.

II. Literature review and hypotheses

The governing board, as a group of corporate executives (Fama & Jensen, 1983), plays an important role in corporate governance (Hillman & Dalziel, 2003). Diversification is a widely recognized viewpoint that can better solve problems and exert greater leadership roles. Jackson et al. (1995) and Milliken & Martins (1996) proposed that diversification can expand a company's cognitive perspective and improve its decision-making ability based on information processing theory (Post et al., 2011). However, some scholars have raised doubts about this, believing that diversity can lead to differences, conflicts, and personnel mobility (Williams and O'Reilly, 1998). The role of diversified management by the board of directors has been constantly debated. One highly debated topic revolves around board diversity.

A. Gender diversity

Due to gender difference in traditional, cultural, and social factors, the gender composition of the governing board is a key issue in enterprise management. Specifically, Buss (2005) and Feingold (1994) argue that there are differences in personality traits, communication styles, educational backgrounds, career experiences, and expertise between male and female college students. So, if a woman is in a powerful position, her choices will be different from those of a man (Ergas and York, 2012). As awareness of the important functions of females in the governing board deepens, the UK has included gender diversity as an important management change recommendation (FRC, 2012). This proposal has also received strong support from institutional investors to raise the diversity of the company's board of directors (Kirsch, 2018; Geletkanycz, 2020).

Previous research indicates that the presence of gender diversity within corporate boards significantly enhances the firm's commitment to social responsibility and environmental performance. Zhang et al. (2013) and Hoang et al. (2018) conducted an empirical test on the relationship between the two and found that gender balance is beneficial for companies in their CSR information disclosure efforts. and improve the moral legitimacy of the enterprise, which is particularly evident in countries with gender equality and more sufficient shareholder rights (Byron and Post 2016). This is partly due to the open attitude of female directors towards environmental affairs.Compared to men, women are more concerned with long-term, autonomous advantages, and altruism, while men are more concerned with the financial performance of the enterprise (Andreoni and Vesterlund 2001; Silverman, 2003; Terjesen et al., 2009).

In addition, the most frequently mentioned theories include the stakeholder theory and gender theory. According to Collier (2008), the corporate boardshould to some extent achieve a balance between shareholders and relevant stakeholders. Studies indicate that women exhibit greater concern for about the well-being of various stakeholders and are more proactive in preventing environmental hazards (Carlson, 1972; Gilligan, 1977). Galbreth (2016) proposed that by coordinating the interests of various stakeholders, promoting their pro social behavior, and thereby enhancing corporate social responsibility. Compared to boys, girls prefer collective behavior and have stronger moral reasoning abilities. Liao et al. (2015) also validated this hypothesis and further revealed that a diversified board of directors can effectively coordinate the interests of various stakeholders. Katmon et al. (2019) also proposed, based on resource theory, that Malaysian women directors can strengthen the operation and management of the company by providing more resources to the board, thereby playing a positive role in the company's social performance. However, this conclusion has limitations and only reflects the current situation in developing countries.

Several studies have analyzed boardroom diversity in more detail. For example, Fan et al. (2023) found that in enterprises, hiring female directors can effectively reduce their carbon emissions, while this effect gradually weakens when women serve as internal directors. Liu (2018) innovatively explored the infringement behavior of enterprises in the field of environmental protection, and based on this, proposed the complementarity between "women" and "CEOs" . The study also pointed out that if a company has a male CEO, the percentage of female directors will be directly proportional to the decrease in environmental litigation. However, due to the lack of consideration for the cost of environmental protection, reducing the frequency of environmental litigation is truly beneficial for businesses.

However, research indicates that the positive correlation between gender differences and environmental performance is not yet clear. Past research has indicated that women directors have a restricted role in advancing environmental protection. (Galbreth, 2011; Hayes, 2001). Campopiano et al. (2023) also questioned the above hypothesis that CSR has traditionally been described as "feminized" and seen as rigid, and as demonstrated by Fletcher (2004), plays an

important role in the functioning of a company. In addition, Nadeem et al. (2020) also found that this phenomenon only occurs within family businesses. Walls et al. (2012) also confirmed that gender diversity has a slightly adverse impact on environmental concerns in manufacturing enterprises. We found that this positive correlation is highly sensitive to specific situations (Glass et al, 2016).

B. Culture diversity

Cultural diversity (measured by racial diversity) is the main driving factor of global climate change. Different occupational backgrounds, religious beliefs, life experiences, knowledge and culture can all have a certain impact on the cognition of CSR (Post et al, 2011). Therefore, when formulating policies, people are more likely to generate new insights and perspectives . Ruigrok et al. (2007) also confirmed this view, stating that the higher the degree of internationalization, the more diverse one's views on a particular issue.

Companies with a significant number of women and external directors have more environmental information disclosure (Cuadrado Ballesteros et al., 2015). Based on this, this project proposes the concept of "diversification" and proposes the concept of "diversification" . Gallego-Alvarez and Rodriguez Dominguez (2023) empirically validated this and conducted large-scale studies on large samples from multiple countries. However, although the variables discussed in this article can be seen as a reasonable alternative indicator of real environmental behavior, the presenceof potential noise generated by the "greenwashing" practices conducted by the company cannot be excluded.

This phenomenon is to some extent explained by the principal-agent theory, which states that managers will take actions that are detrimental to the company in order to gain more personal benefits (Dorataa & Petra, 2008). In this situation, the independent director system is very important. Although foreign directors make up a significant proportion of the board of directors, directors from various countries are able to exchange opinions with each other, creating a creative atmosphere for them. In this context, the government achieves high-quality decision-making by strengthening regulation and supervision (Reguera Alvarado et al., 2015). In this way, the diversified operation of the governing board can effectively prevent the negative impact of the chairman and independent directors on the governing board. Under this framework, the governing board with diverse corporate culture can exercise control more effectively.

An alternative explanation is "legitimacy" . It is crucial to maintain consistency between corporate behavior and social expectations in order to ensure the legitimacy of operations. Nurhayati et al. (2016). So, directors and managers of companies often adopt strategies to demonstrate that the company is doing its best to meet social expectations. Due to the increasing emphasis on environmental protection in society, businesses have also raised their expectations for the environment (Gallego'Alvarez & Rodriguez Dominguez, 2023). Under different corporate cultural backgrounds, enterprises can collaborate with diverse entities across various environments, achieving different performances of different types of enterprises in different types of enterprises, thereby improving business performance and social recognition.

However, some studies have expressed doubts about the positive impact of diversified board culture, and empirically, the two are not consistent. Sharif and Rashid (2014)and others have shown that a diverse board culture significantly enhances sustainable business performance. In addition, a significant negative correlation between the standard of CSR information and differences in corporate culture based on empirical analysis of emerging markets (A. A. Zaid et al., 2020). However, this study also has its shortcomings in that it is descriptive and difficult to quantify. We cannot draw general conclusions about this complex problem. Kang et al. (2019) argue that the nationality, education level, and geographical location of external directors moderates corporate social responsibility participation levels. For example, considering the increasingly strengthened environmental regulations in Europe, Post et al. (2011) discovered a correlation with higher education level and the more supervisors in Western Europe, the higher their environmental CSR obligations. However, the report only investigated European companies and only focused on the electronics and chemical industries.

On the basis of reviewing existing research, we found that it mainly focuses on corporate social responsibility reporting, information disclosure, and company rating (Post et al, 2011). The possible disparity between disclosure and actual practices may lead to potential noise from the "greenwashing" practices conducted by the organization. Some people are also concerned about the political situation of women (Ergas and York, 2012), the private sector, women's participation in public transportation, and environmental groups (such as public transportation and environmental groups). (Xiao Hong, 2010; La Parsi, 2021). These studies seem to lack consensus. One important reason is that CSR is a broad and multidimensional concept, which has not been distinguished in previous research. Therefore, this study takes gender and cultural differences as a whole and only focuses on CO_2 emissions to explore this complex institutional issue. Meanwhile, this article also found that significant variations exist in the effects of board diversification on corporate environmental performance. This association may be moderated by multiple contextual variables such as country, industry, and enterprise, as well as endogeneity issues. Therefore, this project intends to adopt two methods to examine the differences in monetary policy between developed and emerging economies, respectively. At the same time, we also conducted industry analysis to distinguish those industries that are more sensitive to carbon emissions.

Our research provides multidimensional insights into relevant literature, exploring how gender and cultural diversity on a company's board of directors affect its environmental and sustainable development performance, particularly carbon dioxide emissions. This provides information for global policies to promote gender and cultural diversity in business. In addition, the research findings are of great significance to some environmentally conscious investors, as well as to the management and regulatory bodies of companies committed to strengthening corporate social responsibility practices and addressing climate change issues.

III. Dataset and methodology

A. The dataset

This study used two different measurement methods for analysis. The first one is from Bloomberg's database, the Morgan Stanley Capital International Investment Fund Europe Index .This article examines whether similar behaviors exist between companies in developed economies and emerging markets through two independent experiments. This study also conducted industry analysis on industries with lower sensitivity to carbon dioxide emissions.

Our research data is from the Morgan Stanley Capital International Investment Fund (MSCI) and the Morgan Stanley Capital International (MSCI) Emerging Markets Index from 2012 to 2022. On this basis, this project will also perform a series of data cleaning on the samples, removing samples with missing information, to enhance data accuracy and consistency.

From Table I, it can be seen that the average CO_2 emissions from basic material industries are 13.512. The ratio of directors from diverse cultural backgrounds stands at 29.242 and 49.652, correspondingly. In terms of the consumer sector, the average carbon dioxide values of non cyclical stocks and consumer cyclical stocks are 15.714 and 15.365, ranking among the top three in each sector. The mean (difference) of BGP is 28.912, 32.201; The mean BGD (*) is 49.816, 41.989; Other industries, such as energy, finance, healthcare, and industry, have a total carbon dioxide emissions of 13.390, 11.475, 11.729, and 12.520, all of which are at a moderate level. The average BCD value (*) is 40.134, 43.029, 54.212, 46.846. Among them, the average CO_2 emissions from the science, technology, and communication industries are 11.859, while women are 32.107, 24.350, and directors from different cultural backgrounds are 48. It's 8. 02,4. 350. In addition, among the total carbon dioxide emissions, the average BGP (*) of the public sector (15.593) ranks first, with an average BGP (*) of 32.877 and an average BGP (*) of 2 (50.912).

TABLE I
Sample description.

	Percent	CO_2 Mean (+)	BGD Mean (†)	BCD Mean (*)
1. Basic Materials	10.837	13.512	29.242	49.652
2. Consumer, Cyclicals	15.706	15.365	32.201	41.989
3. Consumer, Non-Cyclicals	7.134	15.714	28.912	49.816
4. Energy	5.922	13.390	25.430	40.134
5. Financial	22.480	11.475	28.912	43.029
6. Healthcare	7.625	11.729	32.212	54.212
7. Industrial	18.838	12.520	25.421	46.846
8. Technology	6.906	11.859	32.107	48.802
9. Telecommunications	5.553	14.493	24.350	46.350
10. Utilities	4.385	15.593	32.877	50.912

(+) Mean of total CO_2 and CO_2 equivalent emissions in tonnes, expressed as a logarithm.
(†) Mean of the percentage of women on the board of directors.
(*) Mean of the percentage of members on the board of directors with a cultural background that is different from that of the company's headquarters.

This project found through research on different industries (such as healthcare, technology, etc.) that in some industries (such as healthcare, technology, etc.), There is a positive correlation between the proportion of female directors and their representation.

B. Variables description

In terms of explanatory variables, this project will characterize the response of enterprises to CSR actions using the logarithm of CO_2 (CO_2) and CO_2 equivalent (CO_2), rather than based on industry averages from other studies (Liu, 2018); We see this as a direct reflection of carbon dioxide emissions and environmental issues.

This study uses three different control variables: market proportion, financial indicators, and environmental policies. We focus on market share, which reflects investors' longterm views on the company. PTB (price to book ratio) is a financial valuation method used to measure the current market value and book value of a company; PM (Stock Price Multiple) is generally used to measurethe correlation between the current stock price of a company and its earnings per share.

Financial indicators mainly refer to the return on assets of a company, through which we can understand the profitability and total asset level of the company; INC represents the logarithm of a company's annual revenue; DTE (Debt to equity ratio) is an indicator of a company's financing ability, which is measured by dividing the total debt of the company by shareholder equity. These variables depict the current financial status of the enterprise. Prior research have shown that the influence of these factors on carbon emissions varies.

This project draws on the research approach of Valls Martnez et al. (2020) and constructs five new dummy variables to evaluate a company's environmental commitment. These virtual variables include: ERP reflects whether the company has corresponding emission reduction strategies; TER indicates whether the company has established emission reduction targets; Environmental accounting standards refer to companies disclosing their environmental expenses in order to reduce risks and improve future opportunities; The environmental protection plan reflects whether the company has corresponding policies to boost its energy efficiency; The Business Development Index measures whether businesses have had an impact on biodiversity, or whether they have reduced their impact on local ecosystems, species, and biodiversity. If the company has set the above policies, assign them 1, otherwise assign them 0.

Based on previous research, with the goal of mitigating the environmental effects of heavily polluting industries, the virtual variable SEN is used to characterize the carbon emission sensitivity of enterprises (basic raw materials, non cyclical consumption, energy, and utilities). If present, each variable is assigned a value of 1 and 0, respectively.

On this basis, this project intends to explore the main factors affecting carbon emissions in China through two independent empirical analyses conducted nationwide. Therefore, this article uses a dynamic marginal utility function as a dummy variable. When the headquarters of a company is located in an emerging economy, the value of this indicator is 1, and vice versa, the value of this indicator is 0.

Previous studies have addressed reverse causality between CSR performance and gender diversity on corporate boards by employing instrumental variables to measure the percentage of women directors. (BenAmar et al., 2017). Reducing emissions is of great significance in corporate social

responsibility (CSR). On this basis, this project will also use multiple instrumental variables to infer whether there are female directors in the governing board and reveal their relationship with gender differences among shareholders. Most European countries have implemented quota systems, which will enable more women to become independent directors. This project takes the ratio of independent directors in listed companies as the instrumental variable (Valls Martnez et al., 2019) as the research object. Enterprises have placed more emphasis on gender diversity in management positions, so we have chosen EGP as the research object to measure the proportion of female executives in the enterprise. In addition, the proportion of female directors in the governing board may also be related to the following instrumental variables: GDP refers to whether there are specific policies regarding gender diversity; HRP has formulated a policy on behalf of the company to ensure respect for human rights; The CDC represents a childcare facility for children, indicating whether company employees have childcare facilities for their children (number and Velte, 2021). Finally, we use the proportion of directors with a specific industry or strong financial background as an instrumental variable. The reason for making such a decision is that committee members are appointed based on their abilities rather than quotas, and due to long-standing obstacles such as "glass caps", women's promotion opportunities are limited (Mateos de Cabo et al., 2010).

C. Methodology

Firstly, this project distinguishes developed economies from emerging economies through descriptive statistics of each variable and t-test of binary correlation coefficients. This analysis aims to confirm significant changes in the methods used in different regions where institutions are located. In addition, regarding the proportion of female directors, this article explores the differences in this ratio among countries by setting a dummy variable and using the average as a reference point. In addition, other tests were conducted to distinguish between enterprises operating in industries with high CO_2 emissions and those operating in insensitive areas, as well as those with high cultural differences.

Secondly, this study used OLS analysis method to explore the influence of female director ratio on carbon emissions. This project aims to avoid endogeneity issues caused by disturbances from other variables by introducing a new variable, the time delay factor, based on previous research (Francoeur et al., 2019). This project aims to classify the samples based on existing full sample data and classify them into developed countries, emerging economies, industries that are more sensitive to carbon emissions, or other industries. Therefore, we conducted 5 OLS estimates In order to address concerns regarding omitted variables, The article utilizes a panel data approach, combining both time series and cross-sectional data for analysis.This project will draw inspiration from Miralles Quiros et al. (2017) and use Hausman's (2017) method to investigate if the fixed effects model surpasses the random effects model in performance.

Each model was evaluated using the f-statistic and R2 metric. At $p < 0.05$, the f-statistic represents the collective significance of all parameters within the model, while R2 represents the percentage that can be accounted for by a set of regression methods for the dependent variable. On this basis, this project will also use methods such as Chi Chi theory and Bayesian information standards (AIC, BIC) to conduct adequacy tests on OLS and panel data models. The smaller the AIC and BIC values, the more sensitive the industry or industry is to pollutants.

On this basis, this project introduces cultural diversity in optimizing the fixed effects model. This combined model will be applied to both the full sample and four distinct subsamples. An analysis was conducted nationwide to illustrate the differences in the samples. To improve the credibility of the research results, we will include the largest number of observed countries. In addition, this study also conducts industry analysis based on the different business operations of enterprises.

In terms of robustness testing, this project intends to adopt more advanced econometric analysis methods to explore endogeneity issues such as implicit variables, reverse causality, and missing variables. On this basis, this article proposes a series of strategies to evaluate the stability of fixed effect models. Firstly, we used instrumental variables for fixed effects estimation and replaced the proportion of female directors with five instrumental variables and other explanatory variables. The second-order generalized moment method (GMM) can more efficiently solve this problem than the first-order model and achieve better results while ensuring minimal data loss. In addition, we use residual regression coefficients instead of the proportion of female directors to estimate CO_2 emissions. This method only requires processing the unknown variance of BGP variables, thus overcoming endogeneity issues. Finally, this study utilized variables for benchmark model estimation to evaluate the stability of the research findings.

IV. Results

A. Methodology

Table II outlines the descriptive statistics associated with each variable. The results indicate that the average carbon dioxide emissions of the three atmospheric pollutants mentioned above are 11.921, with emissions ranging from 11.921 to 54.617. Regarding the makeup of the board, the percentage of female directors stands at only 17.276, accounting for 17.276-46.188, indicating an imbalanced gender ratio. On the contrary, the average score of BCD is 7.847, indicating less cultural diversity. The average ROE is 6.515, ROA is 24.728, ROA is 8.388, and DTE is 7.596. While the number of PTB is between 6.515 and 44.147, that of ROA ranges from 8.388 to 59.634. The minimum PM is 24.728, the DTE is 7.596, the maximum is 47.332, and it is 53.682, indicating significant differences in the financial outcomes of listed firms in China. The average annual revenue of a company is 20721.

From the perspective of sustainable development performance, 60% of companies have formulated corresponding emission reduction measures, and 48% of companies have clear emission reduction targets. Approximately 12% of companies have announced their spending on environmental protection, while approximately 78% of companies indicate that they have had an impact on biodiversity. More than 17% of companies have a clear attitude towards energy

TABLE II
DESCRIPTIVE STATISTIC.

Variable	SD (+)	Maximum	Minimum
CO_2	32.167	54.617	11.921
BGP	35.422	46.188	17.276
BCD	31.804	54.797	7.847
PTB	27.973	44.147	6.515
PM	31.804	47.332	24.728
ROA	35.434	59.634	8.388
INC	27.963	51.530	20.721
DTE	35.317	53.682	7.596
ERP	26.785	50.985	6.108
TER	36.164	56.004	4.823
SEP	32.167	54.617	11.921
EEP	35.422	46.188	17.276
BID	31.804	54.797	7.847
IDB	27.973	44.147	6.515
GDP	31.804	47.332	24.728
CDC	35.434	59.634	8.388
HRP	27.963	51.530	20.721
EGP	35.317	53.682	7.596
BSB	26.785	50.985	6.108
DEV	36.164	56.004	4.823
SEN	32.167	54.617	11.921

(+) Standard Deviation.

conservation and have introduced corresponding policies. In addition, we can also see that nearly half of the companies are headquartered in emerging economies, and about 12% of them are in this field of carbon emissions. In 6.5% of enterprises, independent directors account for a larger proportion, compared to only 7.6%. Especially, over 24% of enterprises have formulated specialized policies on gender diversity, 20% of enterprises have formulated policies to protect human rights, and 83% of enterprises provide childcare services to employees. In addition, 61% of directors with strong financial strength in a specific industry serve on the executive board.

The t-test in Table III shows that, except for ROA and Gross Domestic Product, the average values of all other variables in developed and emerging economies are significant. The difference in mean values of all variables is significant between developed countries and emerging markets. More gender and culture, higher market valuations, and more resolute implementation of policies related to the environment. However, according to reports, such businesses are rarely conducted (commercial credit) and often operate in industries that are sensitive to carbon emissions.

By comparing the average level of gender differences in the governing board, it was found that companies with greater gender diversity tend to have lower CO_2 emissions and increased investment in ecological conservation. Moreover, such firms facilitate female employment opportunities by providing daycare services and encouraging female to hold administrative positions. This phenomenon is more common in developed countries and industries, which show less sensitivity towards carbon dioxide emissions.

Table IV provides a comprehensive summary that describes the experimental results of various industries, which are sensitive. Especially in insensitive industries, there are some obvious characteristics: on average, women have fewer directors, stronger sales ability, stronger sense of responsibility, and a greater emphasis on reducing emissions. In addition, sensitive industries are more willing to report the cost of reducing environmental hazards (SEP and BID). It must be pointed out that most of the aforementioned industries are concentrated in the developing world.

Through t-test, it was found that the higher the degree of cultural diversity, the less carbon emissions and energysaving plans there are; However, this growth also involves policies aimed at promoting diversity, gender equality, and more female managers. Moreover, in the developed world, the degree of cultural diversity is relatively high.

There is a notable positive relationship exists between gender diversity among directors and both instrumental and environmental variables. In addition, this study also found that an increased ratio of women directors correlates with greater cultural diversity and market value, while their annual income is lower. In addition, in the developed world and environmentally friendly industries, there is a greater difference in the gender ratio in the governing board.

In addition, a distinct relationship exists between the degree of cultural diversity within the board and specific contexts and country dummy variables. Our findings indicate that industrialized countries tend to feature the most culturally diverse board of directors. In contrast, companies engaged in carbon dioxide sensitive industries are mainly located in emerging economies.

B. Regression analysis

Table V presents the research results of listed companies based on MSCI Europe and Morgan Stanley Capital International Europe Index from 2012 to 2022. Research has found a strong inverse relationship between the proportion of female directors and their carbon emissions. This conclusion applies to all samples, with a correction factor R2 between 48.67% and 58.90%. The maximum value of the coefficient of variance expansion (VIF) is significantly lower than the critical value of 10 (Fox and Monette, 1992), indicating the absence of multiple collinearities.

Table VI displays the outcomes derived from analyzing Mode 2. At the same time, this project will also use panel data methods to process sample data to reduce the impact of omitted variables on the sample. All Hausman experiments < 0.05, confirming the applicability of the fixed effects model. Furthermore, compared to AIC and BIC, Model 2 has better applicability. This study found a close correlation between gender differences in directors and their explanatory variables, as well as their statistical significance, with previous studies.

After incorporating different cultural differences among directors, the third model performed better than the second model. Model 3 has a very small AIC, BIC, and a high adjustment coefficient R2.

Research has found that gender differences in the board of directors are an important factor affecting company development, but their impact on carbon emissions is not significant. This conclusion runs through the entire sample, whether in industrialization, emerging markets, or insensitive and sensitive industries, all have the same conclusion.

Previous studies have found that, in addition to risk countries, the degree of board diversification is positively correlated with its explanatory variables. The research results show that the differences in emerging markets are mainly due to their different behavioral patterns or variable performance caused by a small sample size.

TABLE III
DIFFERENCE OF MEANS TEST (T TEST):

Variables	Sorted by Country			Board Gender Diversity (†)		
	Developed countries	Emerging countries	Difference (+)	BGD $<$ 27.5	BGD $\geq$ 27.5	Difference (+)
CO_2	15.110	12.343	-0.353** (0.0001)	14.752	16.045	0.295*** (0.0458)
BGP			18.73* (0.0000)			
BCD	32.313	10.754	21.735** (0.0000)	48.605	50.026	-0.645** (0.6955)
PTB	51.409	27.127	1.544** (0.0000)	4.156	4.270	-0.0526*** (0.0142)
PM	5.209	2.143	12.464* (0.0155)	35.899	36.815	-0.6684** (0.8938)
ROA	37.374	15.140	-0.298 (0.1395)	6.432	6.269	0.669*** (0.0482)
INC	7.409	7.080	-2.425** (0.00150)	24.470	25.460	0.1695* (0.00045)
DTE	24.633	28.305	29.735* (0.0152)	120.181	140.235	-7.6955*** (0.2365)
ERP	138.761	108.142	0.263* (0.0002)	1.062	0.959	-0.0784* (0.02650)
TER	1.068	1.074	0.419** (0.0002)	0.534	0.794	-0.0154* (0.00360)
SEP	0.729	0.345	-0.144** (0.0020)	0.509	0.549	0.0425* (0.0096)
EEP	0.498	0.564**	0.078* (0.0023)	1.076	1.412	-0.0266* (0.0154)
BID	0.809	1.056	0.0582** (0.000)	0.436	0.452	-0.045** (0.0013)
IDB	0.707	0.510	31.294** (0.0000)	67.604	75.079	-4.2545** (0.1266)
GDP	70.551	40.443	0.795(0.0000)	0.685	0.872	0.2845* (0.0000)
CDC	1.003	0.328	0.199** (0.0000)	0.299	0.403	-0.236** (0.0002)
HRP	0.810	0.294	0.449** (0.0003)	0.975	0.534	-0.078** (0.0065)
EGP	0.491	0.479	1.996* (0.00175)	21.368	18.867	4.1145* (0.0536)
BSB	13.982	12.890	0.789** (0.0000)	48.716	43.159	5.99835** (0.0250)
DEV						0.1585* (0.0026)
SEN	47.010	46.907	-0.175** (0.00152)	0.141	0.053	0.016** (0.00229)
			(0.00152)			(0.00229)

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

This indicates that high-income companies tend to reduce environmental pollution, while those that announce environmental policies will generate more carbon dioxide.

Model 3 shows that there exists a notable negative correlation between the count of board members and a company's carbon emissions in each industry, with 7 out of 10 industries being significant.

So, after a detailed industry analysis. Among the nine industries, board cultural diversity positively influences carbon emissions,and it reaches a statistically significant level among the eight industries. However, in the technology industry, although this correlation is not obvious, it is negative. It is worth mentioning that the automotive industry emits the smallest amount of CO_2 , which is a challenge for the automotive industry. So, the correlation with osteocalcin is not significant.

To delve deeper into the analysis, we employed model 3 to examine the data for the 7 most observed countries in the sample. Research has found that gender and cultural differences in the governing board are associated with CO_2 emissions. However, empirical research has found that gender differences in directors have a significant impact on carbonemissions. In this example, 6 out of 7 countries showed significant statistical significance in independent analysis.

C. Robustness check

We tested Model 3 using four robustness tests. Firstly, this study utilizes six alternative variables and a fixed effects estimation method using instrumental factors to identify gender differences in the governing board. Table VIII shows the analysis results of the second stage. To simplify the reasons, the first stage has been removed from Table VII. The research results confirm that in developed countries, there are significant variables in both insensitive and sensitive industries. However, in the latter study, gender differences among directors did not reach significant significance. On the contrary, in emerging economies, cultural diversity of companies has become a major factor, while gender differences in company boards are reversed and no longer as important.

Next, we will use the second level GMM method, as detailed in Table IX. This study found that gender differences in directors have a significant and statistically significant impact on carbon emissions. Moreover, this relationship is not clear in these emerging economies. Similarly, in other countries, apart from emerging markets, cultural diversity is directly proportional to carbon emissions.

On this basis, this study further explored the gender differences in the governing board and used the remaining data as the final regression variable. For simplicity, the second-stage results simply show the final model and do not include BGP estimation. However, these findings are similar to the model 3, showing the latter's reliability.

To reduce the potential impact of outliers, we lowered each variable to the lowest value of 0.01. Afterwards, Model 3 was re evaluated. Surprisingly, these research outcomes align with our preliminary results, which further enhances the reliability of our research findings.

V. DISCUSSION

The current survey results indicate that more female directors of MSCI in European companies between 2012 and 2022 are associated with reducing carbon emissions. This association is not only prevalent in industrialized countries, but also in emerging industries that are both carbon sensitive and non sensitive. In addition, most individual evaluations conducted nationwide and within enterprises also indicate this.

TABLE IV
DIFFERENCE OF MEANS TEST (T TEST):

Variables	Sensitivity			Board Cultural Diversity (†)		
	Nonsensitive	Sensitive	Difference (+)	BCD $\leq$ 27.5	BCD $>$ 27.5	Difference (+)
CO_2	14.804	13.327	-0.436** (0.0125)	13.165	12.412	-0.035** (0.1638)
BGP	31.104	31.346	1.3585* (0.0000)	28.911	31.112	-0.446** (0.4435)
BCD	48.676	43.716	-1.356** (0.1286)	0.000	0.000	
PTB	4.604	3.738	0.355** (0.0526)	3.423	5.553	-0.535** (0.1365)
PM	36.813	26.585	5.355** (0.1757)	37.712	8.619	9.053*** (0.0221)
ROA	6.442	6.364	0.35** (0.0131)	6.356	6.505	0.062** (0.7885)
INC	24.682	23.497	-1.355** (0.0187)	24.379	26.032	-0.053** (0.1696)
DTE	134.720	106.860	39.533** (0.02850)	133.502	158.824	-7.054** (0.3396)
ERP	1.021	0.952	0.0035** (0.6785)	0.860	1.065	0.035* (0.0181)
TER	0.843	0.823	-0.053* (0.0636)	1.065	0.173	0.016*** (0.4853)
SEP	0.361	0.435	-0.0859** (0.048)	0.752	0.424	-0.035** (0.1639)
EEP	0.823	0.834	-0.00533** (0.485)	0.974	1.159	0.0395** (0.0485)
BID	0.487	1.084	-0.0639* (0.0550)	0.400	0.666	0.035** (0.1591)
IDB	71.696	69.460	-0.036** (0.0290)	72.912	72.833	-1.965** (0.00262)
GDP	0.971	0.783	0.235 (0.6785)	0.980	0.956	-0.042** (0.0004)
CDC	0.464	0.831	-0.0035** (0.9968)	0.409	0.534	0.039*** (0.0055)
HRP	1.194	0.391	0.035* (0.0078)	0.402	0.402	-0.006** (0.1141)
EGP	16.939	16.276	0.356* (0.0425)	17.901	16.803	0.53** (0.0062)
BSB	41.991	41.934	0.633** (0.2985)	47.614	46.512	-0.536** (0.1556)
DEV	0.644	0.227	-0.538*** (0.0250)	0.084	0.106	0.053**(0.0003)
SEN	14.804	13.327		0.273	0.941	-0.078** (0.3952)

(†) By considering the mean of Board Cultural Diversity, a dummy variable was created that takes a value of 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. ***, ** and * indicate a significance of less than 1%, less than 5% and less than 10%, respectively.

TABLE V
MODEL 1: OLS

Variable	All samples	Developed countries	Emerging countries	Nonsensitive	Sensitive
Intercept	2.33571** (0.0550)	5.3535* (0.160)	6.89585** (0.059)	6.96835*** (0.590)	4.6395** (0.590)
CO_2 (1lag)	0.033541* (0.000)	0.0539** (0.182)	0.024855 (0.559)	0.09938** (0.595)	0.09685* (0.599)
BGP	-0.353531*** (0.029)	-0.02164*** (0.846)	0.035958* (0.026)	-0.008020584	-0.015985** (0.59)
PTB	-0.046525 (0.139)	-0.051263951	0.001550** (0.292)	-0.00585** (0.261)	-0.00235** (0.866)
PM	0.003355 (0.336)	0.000435 (0.968)	-0.00488 (0.185)	0.0001566*** (0.561)	0.000295 (0.461)
ROA	0.05338* (0.0436)	0.09463 (0.143)	0.046968* (0.059)	0.005985* (0.043)	0.001384 (0.864)
INC	0.13534** (0.6920)	0.129685* (0.035)	0.269878** (0.185)	-0.59289 (0.26)	0.239487** (0.457)
DTE	0.000468 (0.638)	0.04955 (0.968)	0.000186 (0.699)	0.05855 (0.3560)	0.00394 (0.638)
ERP	0.4835455** (0.130)	1.218525** (0.550)	0.678544 (0.286)	1.1496*** (0.050)	-0.94697** (0.269)
TER	1.114352** (0.430)	1.8353632* (0.000)	1.34865** (0.298)	1.1695* (0.250)	0.99678*** (0.6490)
EEP	0.435358* (0.395)	0.51855** (0.485)	-1.109685** (0.045)	0.25595*** (0.089)	0.99684*** (0.649)
BID	2.035536* (0.260)	1.99685*** (0.186)	3.483851* (0.595)	1.86959** (0.0452)	2.07684** (0.6294)
DEV	0.4735535** (0.260)	0	0	0.48996* (0.015)	-0.29467** (0.199)
SEN	0.13558*** (0.048)	0.1755** (0.039)	0.20498 (0.506)	0	0
Adj R2	0.5335	0.48675	0.50468	0.58905	-0.49434
F-stats	394.678* (0.180)	3638.58** (1.835)	25.98** (0.698)	277.85*** (0.026)	96.676*** (0.760)
Sample	6562.6	5539.6	396	4796	1943.7
AIC	28708.108	27894.438	1630.508	16149.738	7696.337
BIC	30579.318	24843.808	1715.208	21921.075	7884.426

In emerging markets, explanatory variables β The coefficient has a higher absolute value, which is consistent with previous research results, that is, the fitting results have a steep slope. The carbon dioxide emissions of emerging economies significantly exceed those from developed nations, thereby presenting a greater potential for emission reduction. Therefore, the actions of the council can achieve greater results.

Industry analysis shows that a rising proportion of female directors correlates with reducing carbon emissions in industries that are sensitive or insensitive to carbon dioxide. However, in the fields of energy, technology, and non cyclical consumption, this correlation is not clear. One possible explanation for this is that women make up a small proportion in the energy sector, so this phenomenon has not received sufficient attention. By contrast, the technology industry may have already begun to address this issue. In fact, there is a critical point where if production is not stopped, there will be no further decrease in carbon dioxide emissions.In other words, every sector has a minimum threshold for contamination that is still unavoidable at the current levels of technology, and mitigating these thresholds requires a scientific breakthrough.

In addition, surveys conducted in seven major European countries have also confirmed a clear trend: among the six European countries, there are more women serving as directors due to their low carbon emissions levels. Italy is a special case among them. It should be pointed out that between 2007 and 2020, Italy and France had the fastest growth in the number of female directors, largely due to legal quota restrictions.

This quota allocation method may result in less qualified

TABLE VI
MODEL 2: FIXED EFFECTS ESTIMATION

Variable	All samples	Developed countries	Emerging countries	Nonsensitive	Sensitive
Intercept	36.3537** (0.0428)	66.646664* (0.699)	20.16799* (0.0679)	25.37994** (0.294)	19.3784** (0.394)
CO_2 (1lag)	-0.026958** (0.067)	-0.018694 (0.699)	0.177992** (0.0036)	-0.067941** (0.136)	-0.06394*** (0.0439)
BGP	-0.023496** (0.297)	-0.02369** (0.598)	-0.002562342	-0.023954** (0.025)	0.012939** (0.0341)
PTB	-0.0024971 (0.169)	-0.0039695 (0.239)	-0.06394 (0.569)	-0.005064 (0.236)	-0.0192 (0.2649)
PM	6.63439 (0.869)	-5.6469 (0.999)	0.00266 (0.949)	-7.67881 (1.076)	-0.000249 (0.694)
ROA	0.06946** (0.358)	0.003591 (0.669)	-0.20649** (0.094)	0.016497 (0.349)	-0.006361 (0.794)
INC	-0.59398*** (0.068)	-0.49496** (0.029)	-0.29439 (0.569)	-0.039562688	0.294375** (0.136)
DTE	0.00549 (0.269)	0.000277 (0.298)	0.0002699 (0.696)	0.000644** (0.379)	0.000496 (0.364)
ERP	0.99687** (0.0069)	1.17969** (0.069)	-0.728694** (0.046)	1.039187*** (0.646)	0.434649** (0.065)
TER	0.98694** (0.000)	1.9678** (0.0054)	1.16958** (0.064)	-1.67669*** (0.644)	0.83493** (0.05)
SEP	1.1384** (0.348)	1.3958*** (0.0699)	-0.12649 (0.896)	1.229649** (0.046)	1.3646*** (0.364)
EEP	0.37684** (0.046)	0.5668* (0.038)	-1.44697** (0.0069)	0.6497* (0.064)	0.79394** (0.005)
BID	2.07684** (0.678)	1.93885** (0.059)	3.79649* (0.994)	2.86784* (0.649)	2.3799** (0.6460)
Intercept	0.51524	0.54318	0.62359	0.54769	0.5159
Adj R2	279.678** (0.360)	366.768** (0.020)	19.378* (0.640)	256.679* (0.496)	62.976* (0.640)
F-stats	6564.8	5813.5	396	5258	1942.6
Sample	706.678** (0.035)	661.3973* (0.066)	77.697* (0.0649)	446.379** (0.349)	26.379** (0.694)
AIC	27925.007	26385.073	1467.367	19870.004	7300.436
BIC	29698.537	26349.037	1582.537	18036.436	7331.236

TABLE VII
FIXED EFFECTS ESTIMATION USING THE INSTRUMENTAL VARIABLE. FIRST STAGE

Variable	All samples	Developed countries	Emerging countries	Nonsensitive	Sensitive
Intercept	36.3537** (0.0428)	66.646664* (0.699)	20.16799* (0.0679)	25.37994** (0.294)	19.3784** (0.394)
Intercept	28.2303*** (0.635)	15.434346* (0.2630)	17.1554** (0.1385)	21.3754*** (0.0294)	16.6878** (0.0597)
CO_2 (1lag)	-0.03485** (0.021)	0.026998** (0.5688)	0.14858** (0.062)	-0.03649** (0.2977)	0.029548* (0.23684)
BGP	-0.02395** (0.550)	-0.027268** (0.000)	-0.07854** (0.568)	-0.03697** (0.619)	-0.01697** (0.546)
BCD	0.008935*** (0.455)	0.007535** (0.298)	0.015638 (0.585)	-0.005397** (0.0549)	0.012697** (0.05490)
PTB	-0.02638 (0.1362)	-0.02395 (0.129)	0.084865 (0.581)	-0.02697** (0.139)	-0.03799** (0.6466)
PM	0.000485 (0.598)	0.002221 (0.896)	0.00869 (0.786)	-0.000949** (0.793)	0.06487** (0.6797)
ROA	0.00588 (0.750)	0.005914 (0.591)	-0.01268 (0.862)	0.01169** (0.316)	-0.011397** (0.6943)
INC	-0.4698** (0.059)	-0.125210921	-0.0845** (0.865)	-0.46436** (0.0294)	-0.2649*** (0.1364)
DTE	0.00085 (0.599)	-0.0557 (0.566)	0.005855* (0.853)	0.00546 (0.644)	0.69476** (0.664)
ERP	0.90885** (0.590)	1.24938** (0.026)	-1.5058** (0.045)	-0.54978	-1.6786** (0.6462)
TER	0.83956* (0.250)	0.85955** (0.26)	1.64868** (0.045)	0.96549** (0.040)	0.46976** (0.0546)
SEP	1.49585** (0.039)	1.15985** (0.295)	0.5838** (0.3568)	1.13664** (0.054)	0.96497*** (0.054)
EEP	0.56698* (0.026)	0.789355* (0.290)	-0.98655*** (0.048)	0.45669** (0.564)	0.669497* (0.642)
BID	1.89685** (0.550)	2.58456** (0.598)	0.5538** (0.059)	1.8698** (0.0248)	2.07684** (0.640)
Adj R2	0.50842	0.50028	0.95568	0.51403	0.51557
F-statistic	178.285*** (0.590)	186.285** (0.680)	9.2845** (0.595)	146.397* (0.064)	49.687*** (0.844)
Sample	4933.5	4988.5	276.1	3779.6	1579.6

female candidates being nominated or limit their impact on the company. Another option is that Italy's regulations on exhaust emissions may be unique, which do not exist in other countries. However, we should also recognize that these are things we have not considered.

This research result indicates that higher levels of carbon dioxide emissions are related to the implementation of corporate environmental policies, which is inconsistent with the traditional assumption of "economic consequences". In this context, we can consider that this inconsistency may be due to companies taking corrective actions only after carbon emissions have reached a certain level. This may be to avoid legal restrictions or to comply with the moral standards of society or advocacy groups. However, we have also found that low-carbon emitting enterprises are considered harmless and comply with relevant regulations. However, we also see that heavily polluting enterprises face dual dangers: on the one hand, there is a risk of government financial or administrative penalties; On the other hand, the huge economic expenditures brought about by negative public opinion.

Promoting consistency between corporate behavior and social expectations is key to ensuring operational legitimacy (Deegan, 2009; Nurhayati et al., 2016). So, directors and managers of companies often adopt strategies to demonstrate that the company is doing its best to meet social expectations. The appointment of women as directors enhances the legitimacy of the enterprise from two perspectives. On the one hand, this is consistent with the primary objective of promoting gender equality and non-discrimination in the 2030 SDG. From another perspective, our research also proves this.

Under the guidance of the European Council, many countries have formulated laws and regulations on the percentage of women in the governing board. However, not everyone agrees with this viewpoint, with critics arguing against enforcement, arguing that corporate directors should be chosen for their ability and expertise, not merely gender.

Research has shown that having women sit in leadership positions is beneficial for both businesses and the environment. If shareholders, business executives, legislators, and the broader community understand, then there is no need for a dynamic mandatory limit. However, this understanding is not entirely in line with reality. The reason is that the ratio of female directors in the governing board of listed companies in China is 6.515%, while the proportion of

TABLE VIII
FIXED EFFECTS ESTIMATION. SECOND STAGE

Variable	All samples	Developed countries	Emerging countries	Nonsensitive	Sensitive
Intercept	16.245*** (0.598)	18.0425** (0.2910)	16.2252** (0.194)	23.6227** (0.0315)	16.3785** (0.549)
CO_2 (1Lag)	-0.02544** (0.020)	-0.006214725	-0.28688** (0.056)	-0.001002843	-0.0325489** (0.1488)
BGP	-0.00226616	0.025651** (0.595)	-0.08988** (0.053)	-0.03166** (0.0545)	-0.02264** (0.0546)
BCD	-0.007899** (0.598)	0.00745** (0.055)	0.030584 (0.560)	0.00567*** (0.054)	0.03945* (0.546)
PTB	0.004957** (0.048)	-0.007533** (0.568)	-0.00898** (0.580)	-0.0076466**	-0.015497 (0.549)
PM	0	0	0	-0.079904	0
ROA	0.000048 (0.458)	0.00598** (0.395)	0.00566** (0.596)	-0.000554** (0.986)	-0.05467** (0.2549)
INC	0.00185 (0.697)	0.002598 (0.668)	-0.00865** (0.485)	0.005246* (0.649)	-0.004615706
DTE	-0.48968** (0.590)	-0.40591*** (0.2940)	0.095978** (0.2984)	-0.49394** (0.646)	-0.263549** (0.2464)
ERP	0.0598 (0.959)	0.005859 (0.395)	0.05988* (0.568)	-0.005773177	-0.24976** (0.954)
TER	0.95828** (0.0590)	1.22956** (0.463)	-1.56398** (0.0596)	0.76346* (0.466)	1.01664** (0.064)
SEP	0.89385* (0.590)	0.85945** (0.590)	1.97387** (0.548)	0.946646** (0.640)	0.496439** (0.549)
EEP	1.7855** (0.296)	-1.2881869	0.68354** (0.2645)	-1.4245** (0.0979)	0.96767* (0.276)
BID	0.55952* (0.595)	-0.6598** (0.000)	-0.685735 (0.2545)	0.48436* (0.054)	0.68679* (0.0576)
Adj R2	1.88659** (0.255)	2.8508* (0.595)	3.1257** (0.650)	1.9468** (0.0584)	1.6767** (0.0646)
F-statistic	0.48345	0.54285	0.71357	0.51073	0.5203
Sample	198.587**(0.698)	186.284*(0.59)	9.6487**(0.548)	145.876**(0.0648)	49.676**(0.042)

TABLE IX
GMM ESTIMATION

Variable	All samples	Developed countries	Emerging countries	Nonsensitive	Sensitive
Intercept	18.235555*** (0.5950)	19.434* (0.2950)	16.375** (0.1646)	21.678** (0.0644)	16.687** (0.0646)
CO_2 (1Lag)	-0.05242** (0.025)	-0.00388 (0.5498)	-0.35354** (0.457)	-0.003030522	-0.036467** (0.1646)
BGP	-0.02244** (0.059)	-0.02495** (0.2980)	-0.0636367** (0.571)	-0.036464** (0.0248)	-0.017545** (0.672)
BCD	0.007248** (0.000)	0.004825** (0.2740)	0.030116** (0.039)	-0.00364** (0.0281)	0.012575** (0.0546)
PTB	-0.0024** (0.585)	-0.005989** (0.552)	-0.006141** (0.8738)	-0.00846*** (0.038)	-0.0195** (0.674)
PM	0.00324 (0.596)	0.04551 (0.5952)	0.001397** (0.6796)	0.00769** (0.9968)	0.000564 (0.269)
ROA	0.001425 (0.968)	0.004559 (0.268)	-0.008098287	0.009649 (0.58768)	-0.006549 (0.5460)
INC	-0.44249** (0.260)	-0.40598** (0.260)	0.09968* (0.876)	-0.499468** (0.6484)	-0.26397** (0.2667)
DTE	0.0028 (0.929)	-0.0595 (0.599)	-0.005497 (0.938)	0.00816** (0.968)	-0.064667** (0.646)
ERP	0.90524** (0.059)	-1.2598** (0.059)	-1.56945** (0.046)	0.96484*** (0.73516)	1.01649** (0.0546)
TER	-0.2425** (0.5950)	0.82859** (0.260)	2.07684** (0.646)	-0.050768058	0.496469* (0.06465)
SEP	1.182455** (0.560)	-1.5928** (0.595)	0.64874** (0.2397)	-0.092232688	1.67964** (0.646)
EEP	0.5624** (0.026)	0.70588** (0.595)	-0.69768 (0.2649)	0.44967* (0.043)	1.6949*** (0.064)
BID	1.99325** (0.2625)	1.9385** (0.585)	3.16494** (0.046)	1.9648** (0.5864)	1.966466** (0.6460)
Adj R2	0.50468	0.6523	0.74085	0.53306	0.48796
F-statistic	168.277** (0.598)	189.5** (0.560)	9.384678* (0.540)	148.687** (0.0846)	49.979*** (0.0642)
Sample	5318.5	5339.4	284.9	4063.4	1579.6

senior directors is 7.596%. This is due to the existence of the board member ratio rule. It is worth mentioning that 83.88% of enterprises have child care institutions, indicating that enterprises should formulate relevant policies to promote equal participation of women across all tiers. Without these terms, gender equality within the organization cannot become a reality, and women often have to do household chores. Strengthening the understanding of such research can help form a social mindset that prioritizes equality and sustainable development, establish a more equal society, and maintain ecological health.

This project will provide scientific basis for achieving gender equality, public health, rational consumption and production, climate change, terrestrial animal and plant protection, and other related United Nations SDGs. Firstly, the bill advocates for greater participation of women in the regulation of businesses and advanced financial decisions to achieve gender equality. This is consistent with the overall goal of promoting gender equality in all fields. Secondly, promote public health and welfare goals, and provide information to reduce diseases and deaths caused by air pollution.

Thirdly, this study is environmentally friendly and aligns with reasonable consumption and production goals to minimize harmful pollution emissions. In addition, this report also explores strategies to reduce the negative impact of climate change on industries, in order to support the development of climate action goals. Specifically, it emphasizes the importance of effective emissions control measures to curb environmental harm. On this basis, measures have been proposed to improve the quality of the atmospheric environment, providing a theoretical basis forsafeguarding land-based plant and animal resources.. Clean air is essential for maintaining biodiversity and ecosystems.

VI. CONCLUSIONS

This project aims to conduct statistical analysis on data from global listed companies and emerging markets from 2012 to 2022, to investigate the correlation between gender and cultural disparities within corporate boards., as well as their impact on CO_2 emissions. The study also shows that as the number of directors increases, their carbon emissions also decrease, but ethnic diversity has a negative effect on them. In addition, sustainable strategies adopted to reduce carbon emissions can also have adverse effects on business performance. This study emphasizes that the main reason why enterprises engage in environmental protection activities is their legitimacy at the domestic and social levels.

This project will compare and analyze the composition of female employees, cultural background differences, CO_2

emissions, and other factors in sensitive and insensitive industries between developed and developing countries, providing new references for existing research on gender issues. On this basis, this article systematically studies the relationship between cultural diversity and carbon emissions from various angles.

This discovery provides a new perspective for corporate executives, shareholders, and decision-makers, and highlights the necessity of strengthening gender diversity in corporate boards of directors. This is because women are able to express their opinions in their own way, which not only enhances environmental awareness but also enhances the respect and trust of shareholders in the company. In this way, the company can gain a clear competitive advantage in the competition. Policy makers can promote corporate diversification and fairness through legal and awareness raising campaigns. Furthermore, public departments might promote the inclusion of board female representatives to contribute to the achievement of the UN's 5 sustainable development objectives.

While this research is of great significance, we also need to pay attention to certain shortcomings. Firstly, this paper focuses on European listed companies as the research object, and the conclusions of this paper may not necessarily be applicable to other countries. Future research should focus on the interrelationships between different regions around the world. Secondly, the study only covered larger listed companies and did not include unlisted companies and small and medium-sized enterprises that accounted for the majority of the company's shares in the statistical scope. To overcome this challenge, future researchers can include this type of enterprise in their research. To overcome this challenge, future researchers should include such companies in the sampling range. Although there are certain limitations, this report has gained great value by analyzing both developing and developed countries through long-term research. On this basis, this project will also classify China's carbon emissions into CO_2 sensitive industries, CO_2 insensitive industries, and countries at different stages of development.

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