DISCUSSION PAPER SERIES

DP17159

Does gender diversity in the workplace mitigate climate change?

Yener Altunbas, Leonardo Gambacorta, Alessio Reghezza and Giulio Velliscig

FINANCIAL ECONOMICS

CEPR

ISSN 0265-8003

Does gender diversity in the workplace mitigate climate change?

Yener Altunbas, Leonardo Gambacorta, Alessio Reghezza and Giulio Velliscig

Discussion Paper DP17159
Published 30 March 2022
Submitted 29 March 2022

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

This Discussion Paper is issued under the auspices of the Centre's research programmes:

- Financial Economics

Does gender diversity in the workplace mitigate climate change?

Abstract

We match firm-corporate governance characteristics with firm-level carbon dioxide (CO2) emissions over the period 2009-2019 to study the relationship between gender diversity in the workplace and firm carbon emissions. We find that a 1 percentage point increase in the percentage of female managers within the firm leads to a 0.5% decrease in CO2 emissions. We document that this effect is statically significant, also when controlling for institutional differences caused by more patriarchal and hierarchical cultures and religions. At the same time, we show that gender diversity at the managerial level has stronger mitigating effects on climate change if females are also well-represented outside the organization, e.g. in political institutions and civil society organizations. Finally, we find that, after the Paris Agreement, firms with greater gender diversity reduced their CO2 emissions by about 5% more than firms with more male managers.

JEL Classification: G12, G23, G30, D62, Q54

Keywords: Carbon Emissions, Female managers, Global Warming, Paris agreement, Green economics

Yener Altunbas - y.altunbas@bangor.ac.uk
Bangor University

Leonardo Gambacorta - leonardo.gambacorta@bis.org
Bank for International Settlements and CEPR

Alessio Reghezza - alessio.reghezza@ecb.europa.eu
European Central Bank

Giulio Velliscig - velliscig.giulio@spes.uniud.it
Università degli Studi di Udine

Acknowledgements
We thank Emma Claggett, Luiz Pereira da Silva and two anonymous referees for comments and suggestions. We are thankful to seminar participants at the BIS and in, particular, to Magda Erdem, Boris Hofmann, Kumar Jegarasasingam, Enisse Kharroubi, Taejn Park and Kostas Tsatsaronis. The views expressed are those of the authors and do not necessarily reflect those of the BIS and the ECB.

1. Introduction

Climate change poses major risks to the global economy as it affects the availability of resources. The Intergovernmental Panel on Climate Change (IPCC) has concluded that the level of greenhouse gas emissions observed since the mid-twentieth century will probably lead to global warming reaching 1.5°C above pre-industrial levels between 2030 and 2052 (IPCC, 2018). This would cause long-lasting changes, increasing the probability of a severe, pervasive and irreversible impact on people and ecosystems. Rising temperatures and changes in weather conditions would hit most sectors – most directly agriculture, fisheries, energy, tourism and construction – with immediate consequences for national economies (EEA, 2012). The number of natural disasters worldwide and the value of (insured and uninsured) associated economic losses have risen sharply over the last four decades (Nordhaus, 2019).

The Paris Agreement, signed in December 2015, was a milestone: countries representing 97% of global greenhouse emissions agreed to respond to global warming by keeping global warming at less than 2°C above pre-industrial levels. Furthermore, the agreement invited nations to publicly communicate their mid- and long-term strategies for reducing gas emissions through Intended Nationally Determined Contributions (INDCs). It also increases peer pressure with regard to meeting global warming targets, as signatories are committed to rapidly reducing carbon dioxide (CO_2) emissions to achieve net-zero emissions in the second half of the twenty-first century. The rules for the Paris climate accord were finalized at the 26th Conference of the Parties (COP26) in November 2021, including transparency regulations for how countries report their emissions and funding to help countries to adapt to climate change.

The literature on combating CO_2 emissions can be divided into country- and firm-level studies. The former seek to identify the country-level drivers of CO_2 emissions, which can be summarized as follows: economic growth (Coondoo and Dinda, 2008; Ergas and York, 2012; York, 2008); population growth (Dietz and Rosa, 1997); urbanization and industrialization (York et al., 2003); foreign direct investment (Jorgenson, 2007); military development (Jorgenson and Clark, 2009); and income inequality (Ravallion et al., 2000). Firm-level studies focus on either carbon disclosure practices or actual emissions reduction. The literature on the former has identified several firm-specific characteristics that may affect carbon disclosure, such as size, profitability, leverage, age and industry (Gonzalez-Gonzalez and Ramírez, 2016). Meanwhile, the literature on actual carbon emissions investigates the relationship between carbon emissions and firm value and performance (Matsumura et al., 2014). Nonetheless, firm-level studies barely address the moderating role of corporate governance characteristics on carbon disclosure practices and carbon emissions, especially as regards the role of gender diversity. Indeed, the literature on gender diversity at the corporate level has two main branches investigating corporate social responsibility (CSR) disclosure and performance (see the reviews by Byron and Post, 2016), and develops along several minor streams which concern: the gender pay gap (Bugeja et al., 2012; Homroy and Mukherjee, 2021), company financial performance (Greene et al., 2020; Sun and Zou, 2021), company capital structure (Schopohl et al., 2020) and company size (Li and Chen, 2018).

Even though the environmental, social and governance (ESG) metrics used to assess CSR performance and disclosure embed companies' data about greenhouse gas emissions, little attention has been devoted so far to the link between companies' gender diversity and CO_2 emissions. The literature investigating this relationship has explored women's political status, consumption behavior and position in the labor force (Natby and Rönnerfalk, 2018). The few studies that investigate the relationship between companies' gender diversity and carbon emissions have focused only on female board directors (not women employed at the managerial level, which makes most practical decisions), reaching conflicting findings as regards both carbon disclosure and emissions (Liao et al., 2015; Prado-Lorenzo and Garcia-Sanchez, 2010; Ben-Amar et al., 2017; Haque, 2017).

In this paper, we take a different perspective and investigate the relationship between the percentage of women in managerial positions and CO_2 emissions. While directors' decisions shape firms' approach to environmental issues, managers are those that select the suitable strategy to achieve firms' objectives. It follows that if female managers are more inclined towards environmental protection than their male peers, a firm with more female managers is likely to display greater CO_2 reduction. To the best of our knowledge, our paper is the first to analyze the role played by women in managerial positions in containing firms' level of carbon emissions.

The relationship between female managers and carbon emissions can be considered in the light of the perils posed by global warming to women's lives and their possible predisposition to counter this phenomenon. According to several studies (Barber and Odean, 2001; Levi et al. 2014; Huang and Kisgen, 2013), women appear to be less overconfident and have greater perception of risk. This may suggest that women are less likely to underestimate the consequences of their decisions on the environment or to overestimate their ability to come up with proper solutions. In addition, women seem to be more ethical than men as they are more inclined than men to believe that questionable actions like taking bribes, breaking rules and misusing private information is unethical (Franke et al., 1997). Consequently, endorsing policies that are damaging to the environment might be considered by women as unacceptable, even comparable with fraud. As suggested by Eagly (1987) and Eagly and Wood (1991), women tend to be more compassionate, caring and inequality-averse than males as a result of their roles in raising children and caring for the household. As such, they might be more likely to take into account the overall wellbeing of society without necessarily focusing narrowly on the interest of shareholders. For these reasons, women's livelihoods tend to be more climate-sensitive than men's. Women's aforementioned social sensitivity, in conjunction with cultural and social practices, could lead to them demonstrating stronger pro-environmental behavior than their male peers (Chodorow, 1978; Dawson, 1997). As a result, women may be more inclined to solve the problem of climate change, if effectively included in the environmental decision-making.

Tackling environmental issues therefore requires empowering women, who are generally underrepresented in government and industry, to play an active role in combating global warming (Collins, 2019). However, despite improvements in gender diversity among listed firms, women still struggle to have a voice in the decision-making process due to individual, cultural and institutional barriers. This is particularly true on companies' boards, as women have yet to reach the critical mass necessary to increase their participation and influence (Granovetter, 1978; Kanter, 1977a, b, 1987). At the managerial level, these obstacles are partly offset by the wide discretion that managers have in terms of how to meet the objectives of the board's strategy (Hemingway and Maclagan, 2004). Female managers could harness such freedom and outperform their male peers with respect to the environmental results that firms are targeting. Indeed, we argue that female managers take better account of the environmental implications of their decisions, demonstrating empathic behavior, social sensitivity and risk-aversion, for climate risks in particular. As a result, female managers may reduce the environmental impact of their implementation strategies with respect to those of male managers.

The recent increasing attention paid to the link between gender and climate change (Collins, 2019) motivated us to delve into this subject with a specific focus on the relationship between female managers and CO_2 emissions, which has been mostly overlooked by the literature. A preliminary investigation of this relationship seems to indicate that a higher percentage of female managers is associated with lower levels of CO_2 emissions, suggesting that female managers play an important role in reducing carbon emissions (Figure 1). These results, however, merely indicate a negative correlation between female managers and CO_2 emissions. This paper deploys an appropriate econometric analysis and a robust theoretical framework to support this connection.

This paper makes a number of important contributions to the literature on corporate gender diversity and CO_2 emissions. First, we focus on the managerial level, as opposed to the focus on board gender diversity in the literature investigating either carbon disclosure (Liao et al., 2015; Prado-Lorenzo and Garcia-Sanchez, 2010; Ben-Amar et al., 2017) or carbon emissions (Haque, 2017). Second, our sample extends other studies' analysis quantitatively (number of firms and countries) and qualitatively (different sectors). Third, we improve the granularity of data on the level of CO_2 emissions across firms by using firm-level data (Scope 1 and Scope 2) rather than the carbon emission aggregate indexes or carbon performance indicators employed by the above-mentioned similar studies. Fourth, from a policy perspective, we delve into the role played by female managers in facilitating the implementation of the Paris Agreement as regards firms' carbon emissions reduction. Finally, we also investigate whether institutional characteristics, such as higher female political engagement or community involvement; cultural or religious barriers, such as the dominance of the "male-breadwinner" model and Catholicism, respectively, favor or limit female managers' impact on CO_2 emissions.

The rest of this paper is organized as follows. Section 2 discusses the related literature in more depth; Section 3 describes the methodology employed and the dataset; Section 4 presents the baseline results; Section 5 provides some robustness checks; and Section 6 concludes.

2. Literature review

The literature examines the relationship between women and the environment starting with the formation of gender identity and the beliefs in gender roles put forth by the *gender socialization theory* (Chodorow, 1978) and the *social role theory* (Eagly, 1987), respectively.

The gender socialization theory posits that the mother-child relationship shapes gender identity in early life; women are raised from childhood to be more nurturing and compassionate. The main thesis of the social role theory is that the division of gender roles in a society shapes gender stereotypes; women are deemed more communal and concerned for others because of their responsibility in raising children and caring for the household.

Thus delineated, traits commonly associated with women, like empathic behavior and social sensitivity, coincide with strong environmental attitudes, concerns, and behaviors (Davidson and Freudenburg, 1996; Zelezny et al., 2000; Dietz et al., 2002; Mohai, 1992; Xiao and McCright, 2007, 2013, 2014). In corporate governance literature this is a cornerstone around which investigations of female engagement in the environmental decision-making process develop.

For firms' boards, according to the *resource dependency theory* (Pfeffer and Salancik, 1978), gender diversity, especially in terms of traits commonly associated with women, represents a critical resource for establishing an environmentally and socially responsible approach (Fernandez-Feijoo et al., 2014). Moreover, according to the *stakeholder theory* (Freeman, 1984), the presence of female directors on boards strengthens relationships with stakeholders, especially as regards environmental and social objectives (Hussain et al., 2018). However, in line with the *token theory* (Kanter, 1977), women often represent a minority on corporates' boards, so their influence on thought, problem-solving and decision-making processes may be limited. A solution is thus provided by *critical mass theory* (Granovetter, 1978; Kanter, 1977a, b, 1987), which posits that increasing the percentage of women on boards from a few "tokens" (one or two) to a consistent minority (at least three) permits their influence to be effective. In this regard, the proportion of companies that reach the critical mass of 30% of women on their boards rose from 2% in 2009 to 16% in 2019 (Kurosaki and Gao, 2020). If, female directors overcome barriers to expressing their opinions and being heard, then, in line with the *upper echelon theory* (Hambrick and Mason, 1984), values like environmental protection can be consistently shared among board members and embedded into the firm's strategy, thus facilitating management's implementation task.

In terms of the management level, despite gender diversity in principle not having any influence as top management teams only execute the board's strategy, the reality is that top managers have wide discretion about how to meet the objectives of that strategy. Managers can therefore enhance firms' environmental performance (Hemingway and Maclagan, 2004). Moreover, it has been suggested that female managers are better suited to achieving the environmental objectives of the board strategy than their male peers thanks to their greater attention to such objectives' long-term results (Berrone and Gomez-Mejia, 2009). By contrast, male managers may be more focused on short-term strategies with rapid results that allow them to increase their prestige. Under the premises of the *agency theory* (Fama and Jensen, 1983; Jensen and Meckling, 1976), therefore, including more women in top management positions might ease the board task of aligning managers' interests with stakeholders' increasing concern about environmental issues. In addition, as regards the actual implementation of the board's strategy, women's greater perception of risk (Croson and Gneezy, 2009; Faccio et al., 2016), in particular climate risk (Bord and O'Connor, 1997), may help female managers commit more than their male peers to lowering the environmental impact of their decisions rather than simply abiding by the strategies' objectives.

From an empirical standpoint, the literature measures the contribution provided by gender diversity at the corporate level in addressing environmental issues in terms of CSR disclosure and performance (see the reviews by Byron and Post, 2016). However, environmental, social and governance factors which trace and measure CSR are usually considered together as aggregate measures. These studies therefore lack a focus on specific issues like greenhouse gas emissions, in particular CO_2

emissions. The studies considering the relationship between gender diversity at the corporate level and greenhouse gas emissions are few and provide contrasting results.

On carbon disclosure, Liao et al. (2015), studying a sample of 329 companies included in the 2011 CDP FTSE 350 reports, find that board gender diversity increases the likelihood of greenhouse gas emissions disclosure in terms of both propensity and extensiveness. However, Prado-Lorenzo and Garcia-Sanchez (2010), studying a sample of 283 companies listed on the FTSE GEIS which completed the 2008 CDP6 questionnaire, despite recognizing the contributions of female board members in enhancing carbon disclosure, point out that the board is more focused on its traditional responsibility of creating economic value instead of monitoring corporates' environmental reporting. Ben-Amar et al. (2017), studying a sample of 541 listed firms included in the Canadian Spencer Stuart Board Index (CSSBI) and covered in the CDP Canada annual survey for the period 2008–2014, find that the likelihood of voluntary greenhouse gas emissions level disclosure increases with the percentage of women on boards.

Regarding carbon emissions reduction, Martin and Herrero (2020), studying a sample of 644 nonfinancial European Union-based companies for the period 2002-2017, find that board gender diversity is positively associated with reductions in CO_2 emissions. However, Haque (2017), studying a sample of 256 non-financial firms listed on the FTSE ALL share price index for the period 2002-2014, does not find any relationship between board gender diversity and a firm's greenhouse gas emissions. This finding is supported by the study of Adams and Funk (2012) on gender differences in the boardroom, which indicates that such differences are not in line with those observed in the population, suggesting a weaker difference in green attitude between female and male directors that may explain the statistically insignificant relationship between female directors and CO_2 emissions found by Haque (2017).

Our study differs from the aforementioned ones in several respects. First, we take a different perspective by looking not at the individuals within an organization who take decisions (the board of directors) but rather at those who implement the decisions. We argue that, since managers have discretion in selecting the best strategy to achieve a firm's strategic objectives, a more gender-diverse management is more suitable to deal with environmental threats as women (as discussed above) have a natural predisposition to counter climate change. To the best of our knowledge, this paper is the first to look at the level of carbon emissions by considering the role played by females in managerial positions. Second, we expand on the existing research in terms of quality, as regards the number of firms and relative countries involved, and in terms of quality, as regards the number of sectors considered, the sample used so far by similar studies. Third, previous studies employ carbon emission aggregate indexes or carbon performance indicators to assess firms' level of pollution. Contrary to these studies, we employ firm-level CO_2 emissions (Scope 1 and Scope 2), which allows us to exploit more granularity in the level of CO_2 across firms. Fourth, we add to the extant literature by analyzing whether gender diversity is strengthening or weakening the effect of policies focused on combating climate change such as the Paris Agreement. Finally, we deepen the investigation of some institutional, and cultural and religious, factors which may blur or sharpen female managers' environmental focus.

Our thesis is that a higher percentage of female managers helps organizations by enhancing their environmental performance in terms of reductions in CO_2 emissions. Women's pro-environmental focus permits female managers to grasp the environmental implications of their decisions, therefore ensuring that the decisions they take in implementing the board's strategy have lower environmental impact.

We therefore formulate the following hypothesis:
H_1: The number of women holding managerial positions is negatively related to CO_2 emissions, suggesting a role for female managers in reducing carbon emissions.

3. Methodology

To investigate the relationship between the percentage of females covering managerial positions and firm carbon emissions, we employ, as baseline specification, a panel fixed effects methodology. The econometric equation is specified as follows:

$$Log(CO2)_{it} = \alpha_i + \beta \% FManager_{it} + \theta X_{it} + \delta Z_{it-1} + \gamma_{jt} + \varepsilon_{it} \quad (1)$$

where i, j, t stand for firm, country and time, respectively. Our dependent variable, $Log(CO2)_{it}$ is the logarithm of CO_2 emissions at the firm level. α indicates firm-fixed effects employed to gauge time-invariant unobservable firm traits. %FManager represents the percentage of female managers in the total number of managers in the organization. X is a vector of corporate governance characteristics that may affect the level of firm CO_2 emissions. Specifically, we include board size (*Board_Size*), measured as the number of directors elected to the board, board gender diversity (*Board_Diversity*), calculated as the fraction of female board members over the total number of members, experienced board members (*Exp_Board*), computed as the percentage of board members who have either an industry-specific background or a strong financial background, and independent board members (*Ind_board*), reported as the percentage of independent board members in the company. *Z* is a vector of firm-specific characteristics including the logarithm of firm total assets (*Size*), the ratio of debt-to-total assets (*Debt_ta*), the Corporate Social Responsibility score (*CSR*), the ratio of firm cash flow-to-sales (*Cashfl_sales*), the return on assets (*RoA*), the book value per share (BVPS) and the historical beta (*Beta*). Firm-specific characteristics are lagged by one period to avoid endogeneity issues related to the simultaneity of balance sheet variables. γ identifies country*time fixed effects which let us control for time-varying unobservable country characteristics that may affect the level of CO_2 emissions over time. Robust standard errors are clustered at the firm level.[1]

The rationale behind the inclusion of firm (or industry) fixed effects is determined by the distribution of female managers across sectors. More polluting sectors hire fewer women in general, as those sectors require greater manual and physical labor. Indeed, the box plot (Figure 2) shows that, on average, the percentage of female managers is skewed to those sectors that are less polluting. Consequently, estimating the between-firm/industry relationship amongst the level of carbon emissions and the percentage of female managers would lead to erroneous conclusions. On the contrary, the inclusion of firm/industry fixed effects allows us to capture the within-firm/industry variation between the level of CO_2 emissions and our variable of interest.

3.1. Data

We use a balanced panel dataset comprising a sample of 1,951 listed companies in 24 industrialized economies over the period 2009-2019 taken from Thompson Reuters Eikon (hereafter, Eikon). From Eikon we also collect information on the Standard Industrial Classification (SIC) codes.[2] Specifically, we download the SIC 1-digit code and the SIC 2-digit code. The SIC 1-digit code is less granular and groups sectors into macro-areas. In our sample, the SIC 1-digit code identifies nine categories: (1) Agriculture, Forestry and Fishing; (2) Construction; (3) Finance, Insurance and Real Estate;

1 In an alternative econometric specification, we include industry and sub-industry fixed effects. As additional analyses and to control for reverse causality and sorting effects, we run a difference-in-difference, propensity score matching and instrumental variable regressions.

2 The SIC is a system for classifying industries by a four-digit code. The SIC codes can be grouped into progressively broader industry classifications: industry group, major group, and division. In detail, the first three digits of the code indicate the industry group, the first two digits indicate the major group and the first digit indicates the division. Each division consists of a range of SIC codes. Our choice of a 2-digit SIC code for industry classification is consistent with De Villiers et al. (2011) who use the same method when studying environmental performance.

(4) Manufacturing; (5) Mining; (6) Retail Trade; (7) Services; (8) Transport and Public Utilities; and (9) Wholesale Trade. The SIC 2-digit code is more granular and identifies 83 sectors in the sample. Table 1 reports the distribution of firms by country based on the SIC 1-digit code. As shown, the majority of firms in our sample are located in the US and the UK – 30% and 18.3% of the overall sample of firms, respectively. This is consistent with the larger presence of listed companies in a market-oriented financial system. Amongst the sectors, the vast majority of companies in our sample operates in the manufacturing sector, accounting for nearly 40% of the overall sample. In addition to the descriptive statistics, we use both industry classifications to provide variation to the baseline identification by including them as industry fixed effects.

3.2. Firm carbon emissions data

Carbon emissions are taken from Eikon and are measured in tonnes of CO_2 per year and are reported at the firm level. Eikon follows the Greenhouse Gas Protocol (GGP), which sets the standard for measuring carbon emissions.[3] It distinguishes between different sources of emissions. Scope 1 emissions refer to direct emissions over a one-year period from sources that are owned or controlled by the company and include emissions from fossil fuels employed in the production process. Scope 2 emissions stem from the consumption of purchased energy (heat, steam and electricity) sourced upstream from the firm. The mean firm in our sample produces 3.035 million tonnes of CO_2 per year (Scope 1 + Scope 2). In Table 2, we report descriptive statistics on pollution by sector. Transport and Public Utilities and Mining produce, on average, the highest level of CO_2 emissions, whilst Retail Trade and Finance, Insurance and Real Estate produce the lowest. Our decision to take firm-level CO_2 emission intensities instead of sectoral breakdowns is motivated by the significant heterogeneity in the level of pollution across firms within each sector. For instance, some of the companies belonging to the cleanest sectors show levels of CO_2 that are higher than the mean of the most polluting sector.

3.3. Firm corporate governance and balance sheet data

Table 3 reports summary descriptive statistics. Both corporate governance variables and firm balance sheet variables are collected from Eikon. Panel B of Table 3 displays summary descriptive statistics of corporate governance variables. %FManagers is calculated as the percentage of females appointed in managerial positions and is our variable of interest in the econometric identification. We expect a negative correlation between this variable and CO_2 emissions because, as explained in Section 2,

[3] More information on the GGP can be found here: https://ghgprotocol.org

women's green attitude enables female managers to deploy implementation strategies with low environmental impact.

We include board size (Board_Size), computed as the number of directors elected to the board. The relationship between board size and the level of CO_2 emissions is not clear-cut, as empirical studies on the relationship between board size and environmental performance provide mixed results. On the one hand, De Villiers et al. (2011) find a positive relationship, arguing that larger boards bring together more diverse backgrounds, experiences and knowledge. This increases the probability of having experts in environmental topics among the members, which may help to deploy effective green policies. On the other hand, Boone et al. (2007) argue that larger boards may suffer from lower efficiency caused by difficulties in reaching agreement and free-riding problems which may cause environmental matters to be overlooked.

We also control for board gender diversity (Board_Diversity), calculated as the fraction of female board members over the total number of members. Board gender diversity enhances awareness of environmental issues as female directors may bring to bear the pro-environmental traits of female personalities, as posited by gender socialization theory and social role theory (Post et al., 2011). In addition, controlling for board gender diversity allows us to better capture female managers' effect on firm CO_2 emissions. Indeed, the omission of gender diversity at the board level as a control variable may lead to endogeneity issues as it can be correlated with our variable of interest (%FManagers), consequently leading to biases in the estimated coefficient.

We employ experienced board members (Exp_Board), computed as the percentage of board members who have either an industry-specific or a strong financial background, to control for heterogeneity in experience among members. Directors with greater human and social capital are better equipped to advise and counsel firms as regards environmental issues, thereby influencing environmental performance (De Villiers et al., 2011). We also control for the percentage of independent board members in the company (Ind_Board). Since non-executive directors have no financial interest in the firm, they may enhance management monitoring of environmental performance. In addition, independent directors may help the board resolve possible agency problems by mediating between environmental and financial objectives (Martin and Herrero, 2020).

Panel C of Table 3 shows summary descriptive statistics for firm balance sheet variables. We control for size, computed as the logarithm of total firm assets. On the one hand, controlling for firm size is fundamental in our regression setting as large firms may produce, by definition, more CO_2 emissions. On the other hand, larger firms are more likely to recognize environmental issues and deploy dedicated resources to limit CO_2 emissions (Al-Tuwaijri et al., 2004; Clarkson et al., 2008). We include profitability (RoA), measured as firm return on assets. More profitable firms show higher environmental performance as they are more likely to bear the cost associated with transitioning toward a greener production process (De Villiers et al., 2011). We control for firm leverage by employing the debt-to-total asset ratio (Debt_Ta). Clarkson et al. (2008) point out a positive relationship between a high level of indebtedness and environmental disclosure. We also control for the cash flow-to-total sales ratio (Cashfl_Sales). Haque (2017) argues that lower free cash flow may hamper climate-related activism, therefore suggesting a positive relationship between the cash flow-to-sales ratio and environmental performance. We use the CSR score to control for differences in the level of CSR performance which may affect a firm's environmental performance. Finally, we include two market variables: the book value per share (BVPS) and the 5-year historical beta.

4. Baseline results

This section discusses the empirical results for the panel data regression analysis based on equation (1). Table 4 reports the findings for different model specifications where we include different combinations of fixed effects. Robust standard errors are clustered at the firm level.

As anticipated, we find a negative and statistically significant (mostly at the 1% level) relationship between the percentage of women appointed in managerial positions (%FManagers) and the level of firm CO_2 emissions. The magnitude of the coefficient is also economically meaningful. Specifically, a 1pp increase in female managers within a company leads to about a half percent decrease in CO_2 emissions. This result supports the hypothesis that women's green attitude helps female managers to better account for the environmental implications of their implementation strategies and, therefore, achieve greater reductions in firm CO_2 emissions.

Among the control variables employed, few display a statistically significant relationship with the level of carbon emissions. Contrary to what we expected, we find that the percentage of board members with either an industry-specific or a strong financial background (Exp_Board) is positive and statistically significant (at the 1% and 5% level) to the level of CO_2 emissions, indicating that experience in the industry is not a positive driver in terms of reducing pollution. As predicted, we document a positive and statistically significant relationship (at the 1% level) between the level of CO_2 emissions and firm size (Size) as larger firms produce more emissions. Surprisingly, we also find that firms with higher CSR scores and historical beta tend to produce higher levels of carbon emissions, but this result is not statistically significant when we include in the specification country*time and firm fixed effects (column 3).

4.1. Female managers and CO_2 emissions: the role of culture and religion

In this section, we investigate whether the relationship between female managers and carbon emissions is affected by cultural and religious factors. To analyze the role of cultural factors, we create a geographical dummy (South) equal to 1 for Southern European countries (Greece, Italy, Portugal, Spain and Turkey), 0 otherwise. The selection of these countries is motivated by the historical predominance of the "male-breadwinner model" (Gonzalez et al., 1999), which posits a hierarchical and patriarchal division of labor and power within the family in which only males support their family with their salaries and women tend to be carers and reproducers. As shown by Figure 3, a statistically significant difference still exists between Northern and Southern countries in terms of female employed in the labor force (weighted on the overall labor force).

Here, we test the hypothesis that the predominance of the male-breadwinner model may limit the effectiveness of female managers' decisions vis-à-vis their male peers. Consequently, a greater percentage of females in managerial positions might not affect the level of firm carbon emissions. To check for this possibility, we interact our variable of interest (%Fmanagers) with the dummy variable South. The results in Table 5 (columns 1-3) confirm that our hypothesis is not affected by geographical considerations, as the double interaction %Fmanagers*South is not statistically significant. While the reduction in CO_2 emissions appears to be slightly higher for those firms which are more gender-diverse at the managerial level in Northern countries, the difference is not statistically significant.

We now turn our attention to the role played by religion. Recent studies (Pew Research Center, 2017; Yeganeh, 2021) investigating the relationship between religion and gender equality find that the influence of Catholicism does not significantly affect gender equality. Contrary to Protestantism, which is positively associated with gender equality, Catholicism is more patriarchal and hierarchical. We add to this recent stream of research by studying whether Catholicism strengthens or weakens females' ability to make environmental decisions within organizations. We exploit the information contained in Figure 4 and create a dummy variable (Catholic) which is equal to 1 if a country has an above-median percentage of Catholics over total population, where the median level is 21%, and 0 otherwise.[4] The results are displayed in Table 5, columns 4-6. Again, the double interaction %Fmanagers*Catholic is

[4] We collect the percentage of Catholics in the total population from the World Population Review. Data can be found here: https://worldpopulationreview.com/country-rankings/highest-catholic-population.

not statistically significant, indicating that reduction in CO_2 emissions is not statistically different for firms which are more gender-diverse at the managerial level in jurisdictions where the population is predominantly non-Catholic.[5]

4.2. Does female representation outside the firm empower women's decision-making within firms?

In this section, we look at how institutional characteristics can strengthen or weaken the relationship between the percentage of female managers and reducing CO_2 emissions. Specifically, we make use of two institutional variables. The first variable (ElectedW) refers to the percentage of female ministers elected during the last elections. The second (CSOW) indicates the degree of women's participation in civil society organizations (CSOs). The variables are transformed on a 0 (lowest score) to 1 scale (highest score). Both variables are constructed as dummy variables where we assign the value 1 if the score is above the median, 0 otherwise.[6]

The results are reported in Table 6. As shown, a higher percentage of female managers helps to reduce the organization's level of CO_2 emissions. However, this effect is stronger in those countries where females are also well-represented outside the organization, e.g. in political institutions and in CSOs – as evidenced by the negative and statistically significant double interactions (%Fmanagers*ElectedW and %Fmanagers*CSOW).

This result is in line with the literature analyzing the relationship between women's political empowerment and CO_2 emissions, which points to a negative and statistically significant association between the number of ministerial posts held by women and reductions in CO_2 emissions (Ergas and York, 2012). In fact, either because of women's "green" attitude, which may be crucial for successful environmental policymaking, or because of the general effect that more gender equality at the political level may have on the way people value the environment, having more female ministers helps promote gender equality and spread environmental awareness, which eases female managers' task in achieving better environmental results at the corporate level in terms of reducing CO_2 emissions.

Higher female representation in CSOs is also effective in strengthening the negative relationship between a greater percentage of female in managerial positions and the level of CO_2 emissions. CSOs are a means for groups or movements to influence policymaking by giving a voice to gender equality

---

[5] Although the %Fmanagers in column 6 of Table 5 loses statistical significance, an F-test for joint significance confirms that the sum of the single and the interaction coefficient is statistically significant at the 10% level (p-value <0.071.

[6] We download both institutional variables from the World Bank GovData360.

and environmental issues. As a result, CSOs support the role of women within enterprises and help their green attitudes, behaviors and concerns influence corporate decision-making, thereby effectively improving the firms' environmental performance.

4.3. Difference-in-differences: a pre-post Paris Agreement comparison

In this section, we employ a difference-in-differences methodology to address possible endogeneity concerns. In equation (1), we suggest that a higher percentage of female managers should improve firm carbon emissions. However, it is also plausible that firms with lower levels of CO_2 emissions are more socially responsible, and hence tend to have a more gender-diverse workplace. If this is the case, our results may be spurious and endogenous. i.e. prone to reverse causality. To address this concern, we employ a difference-in-differences methodology and include the Paris Agreement as a shock (Mesonnier, 2019; Delis et al., 2020; Reghezza et al., 2020).[7] Since the Paris Agreement affects the level of CO_2 emissions but not the percentage of female managers, if the results hold in the difference-in-differences specification, we can more confidently say that the relationship goes from female managers reducing pollution and not vice versa. The difference-in-differences econometric specification takes the following form:

$$Log(CO2)_{it} = \alpha_i + \beta PA_t * FEMALE_i + \theta X_{it} + \delta Z_{it-1} + \gamma_{jt} + \varepsilon_{it} \quad (2)$$

where i, j, and t stand for firm, country and time, respectively. Our dependent variable is, again, the logarithm of CO_2 emissions at the firm level. α indicates firm-fixed effects employed to gauge time-invariant unobservable firm traits. PA is a dummy variable that takes the value 1 after the introduction of the Paris Agreement (from 2016 onwards), 0 otherwise. FEMALE is a dummy variable that takes the value 1 for firms with an above-median percentage of female managers prior to the shock (in 2015), 0 otherwise. X and Z are the same vectors of corporate governance and firm-specific characteristics employed in equation (1). γ identifies country*time fixed effects which let us control for time-varying unobservable country characteristics that may affect the level of CO_2 emissions over time. In this

[7] The Paris Agreement (COP21), signed in December 2015, represents a milestone: countries representing 97% of global greenhouse gas emissions agreed to respond to global warming by keeping it below 2°C. Furthermore, COP21 invited nations to publicly communicate their mid- and long-term strategies for reducing gas emissions through Intended Nationally Determined Contributions (INDCs). COP21 represented the first comprehensive climate deal that explicitly recognised the need to "make finance flows compatible with a pathway toward low greenhouse gas emissions and climate-resilient development". This means pushing for a reorientation of capital allocation (Article 2.1(c)). It also increases peer pressure with regard to meeting global warming targets, as signatories are committed to rapidly reducing CO_2 emissions to achieve net zero emissions in the second half of the twenty-first century.

specification, β is our coefficient of interest as it represents the change in the average level of CO_2 emissions between firms with a greater percentage of female managers after the Paris Agreement.

To be valid, the difference-in-differences estimators require some assumptions to hold. First, treatment assignment has to be exogenous to the level of CO_2 emissions. In other words, the policy action ("intervention") should affect CO_2 emissions and not the level of female managers within an organization. It is reasonable to expect this assumption to hold in our econometric setup as the Paris Agreement is not driven by concerns about gender diversity in the workplace but rather by the potential negative effects on economies and societies of global warming. Second, according to Bertrand et al. (2004) and Imbens and Wooldridge (2009), the difference-in-differences approach is only valid under the restrictive assumption (the "parallel trend assumption") whereby changes in the outcome variables over time would be exactly the same in both the treatment (firm with an above-median percentage of female managers) and the control group (firm with a below-median percentage of female managers). The left chart of Figure 5 depicts the dependent variable (the logarithm of CO_2 emissions) from 2009 to 2015 for both the treated and control group. The level of CO_2 emissions moves in the same direction prior to the Paris Agreement, indicating that the parallel trend assumption holds. The right chart of Figure 5, which is based on the normalized median level of CO_2 emissions measured in tonnes, confirms the parallel trend prior to the Paris Accord. In addition, it shows a larger reduction in the level of CO_2 emissions for those firms that had an above-median percentage of female managers prior to the agreement.

The difference-in-differences results are displayed in Table 7. As in the baseline specification, we document a negative and statistically significant relationship between firms with a greater number of females appointed in managerial positions and CO_2 emissions. Specifically, after the Paris Agreement, firms with an above-median percentage of female managers decrease their carbon emissions by about 5% (column 3 and tightest specification) in comparison with the control group.

This result is important for two reasons. First, it confirms the appropriateness of the baseline results. Second, it offers important policy indications. The transmission channels of climate-oriented policies such as the Paris Agreement are amplified by higher female representation in the workplace. Hence, the complementarities of climate policies and gender diversity can have a significant impact in combating climate change.

In Figure 6, we also plot the time-varying coefficients on the treatment for 2 years before and 2 years after the Paris agreement to study in more detail the dynamics of the effect. Indeed, it is important to analyze if firms with an above-median percentage of female managers reduced their level of CO_2

emissions immediately after the Agreement or whether the reaction was delayed. The slope of the line for the treatment group – compared with the control group – changed markedly in 2017, suggesting that the firms with an above-median percentage of female managers did not react immediately to the Accord. This is reasonable as emissions reductions typically require investments in new technology or a reconfiguring of processes.[8]

5. Robustness checks

5.1. Continuous interaction

As a first robustness check, we replace, in the difference-in-differences specification, the dummy variable *Female* with the continuous variable employed in equation (1), i.e. %FManagers. This allows us: (i) to check whether the results based on equation (2) are consistent across different econometric identifications and (ii) to capture greater granularity in the effect of female managers on firm carbon emissions after the Paris Agreement. Indeed, in equation (2) we grouped the percentage of female managers into two distinctive groups according to the median level. Although this is common in difference-in-differences papers (see, for instance, Heider et al., 2019), considering the continuous variable without defining a treatment and control group allows us to identify how the intensity of female managers in the workplace affects firm-level CO_2 emissions.

The results presented in Table 8 are consistent with the baseline, further strengthening our results. Two important results emerge here. First, the solo coefficient %FManagers indicates that, before the Paris Agreement, a 1 pp increase in female managers within a firm decreases the level of CO_2 emissions by 0.46% (column 1). Second, the interaction PA*%FManagers shows that, after the Paris Agreement, there is an additive effect of female managers. Specifically, a 1 pp increase in female managers in the firm workplace will add an additional 0.24% of decreases in CO_2 emissions after a climate policy such as the Paris Agreement.

5.2. Difference-in-differences PSM

As a second robustness check, we test for the possibility that the difference-in-differences results of equation (2) are driven by differences in the characteristics of the treatment and control groups. If firms with a higher percentage of female managers are consistently different in terms of corporate governance

[8] Additionally, Figure 2 confirms, once more, the validity of the parallel trend assumption as, in the period prior to the Paris Agreement, the estimated coefficients move similarly.

and firm-specific characteristics than firms with lower percentage of female managers, our results might be biased. To test this, we construct a control sample by using Propensity Score Matching (PSM) as proposed by Rosenbaum and Rubin (1983). The predicted probability (propensity score) is estimated via a logit model. We use the full set of control variables employed in the baseline regressions to match firms with a below-median level of female managers (the control group) with the treatment group. We implement a 1:1 nearest neighbor matching with replacement.

The PSM identifies 1,455 suitable matches, while 459 firms are discarded from the analysis as unmatched. Figure 7 shows the kernel density function of the propensity scores between the treatment and control groups pre- and post-matching, indicating that the PSM has indeed improved the comparability between the two groups of firms. The results of the PSM difference-in-differences regressions are displayed in Table 9. As shown, sign and magnitude are in line with the baseline difference-in-difference specification, further strengthening our findings.

5.3. Placebo test

In this section we try to eliminate the possibility that the level of CO_2 emissions in the treatment group may have altered prior to the Paris Agreement, for example, in anticipation of the discussion before the final agreement or due to some firm-specific characteristics, which would invalidate our choice of difference-in-difference estimation. If the estimated coefficients on a "fake" Paris Agreement are not statistically significant, we can be more confident that our baseline coefficient is capturing a genuine policy shock. In Table 10 we report results from estimates in which we shorten our sample to the period from 2009–14, setting the introduction of a fake Paris Accord in 2012. The coefficient "Fake" PA*FEMALE is still negative but smaller and not statistically significant, adding further support to the validity of our baseline estimation.

5.4. CO_2 emission intensity

As an additional robustness check, we use a different computation of the dependent variable. Specifically, we replace the logarithm of CO_2 emissions with a measure capturing a company's CO_2 emission intensity. Although in the baseline regression reported in Table 4 we control for firm size, here we also check for the possibility of size effects in the level of pollution, which could affect our results. Following Bolton and Kacpercyk (2021) we use the ratio of CO_2 emissions measured in tonnes weighted on firm total assets (in billions of euros). On average, firms in our sample produce about 10 tonnes of CO_2 emissions/billion (Panel A of Table 3). Table 11 reports the results when we change the dependent variable. As shown, we find a negative relationship between the percentage of female senior managers and the relative CO_2 emissions, which further corroborates our baseline findings.

5.5. Instrumental variable approach

In this final robustness check, we further control for endogeneity concerns. The literature on self-selection mostly focuses on the role of female directors self-selecting into certain types of firms, for instance those which are more socially responsible (see, for instance, Abdallah et al., 2015). In our case this should be less of a concern as we focus on female managers rather than female directors. However, male managers are also sensitive to climate change concerns. Hence, our result could reflect a correlation rather than causation. Although we already addressed this possibility by performing difference-in-differences and propensity score matching difference-in-differences estimations, we tackle these endogeneity concerns by employing the instrumental variable (IV) approach and estimate regressions using two-stage least squares (2SLS) to extract the exogenous component from the percentage of female managers.

The main challenge in using 2SLS is the identification of exogenous IVs that are not correlated with the dependent variable. Following Atif et al. (2021), we employ the ratio of female participation in the workforce to male participation (Womenpart) for the country of the firm's head office.[9] We employ this instrument as firms in states with greater female participation in the workforce should have more female managers in comparison with firms located in countries where the female representation is low. However, we did not find evidence in the literature that female participation in the workforce at each employment level has an effect on firm CO_2 emissions. Column 2 of Table 12 reports the results of the first-stage regression, where our dependent variable (%Fmanagers) is regressed on the explanatory variables used throughout the paper. In line with the requirements for a valid instrument, Womenpart is positively correlated with %Fmanagers and statistically significant at the 1% level (Column 1), suggesting the validity of the IV. Moreover, the instrument employed is strong, as shown by the Kleibergen-Paap and Cragg-Donald test statistics (Cragg and Donald, 1993; Stock and Yogo, 2005). Column 2 of Table 12 displays the results for the second-stage regression, which makes use of the predicted percentage of female managers from the first-stage regression (%Fmanagers-predicted) to estimate CO_2 emissions. The results are similar (although stronger in magnitude) to those obtained in the baseline regression (column 4), again suggesting an inverse relationship between the percentage of female managers and the level of CO_2 emissions.

[9] The data on female participation in the workforce are from the World Bank database.

6. Policy considerations

Our baseline results about the relationship between the percentage of female managers and carbon emissions have interesting implications. As a 1 percentage point increase in the number of female managers corresponds to a 0.5% reduction in CO_2 emissions, firms are encouraged to promote female participation among top management teams and also redirect recruiting policies towards individuals with a distinct environmentally and socially responsible focus. We document that this effect is statically significant also controlling for institutional differences due to more patriarchal and hierarchical culture and religion. At the same time, we show that gender diversity at the managerial level has stronger mitigating effects on climate change if females are also well-represented outside the organization, e.g. in political institutions and civil society organizations.

In addition, complementary insights for policymakers can be drawn from our impact assessment of the Paris Agreement and COP26 deliberations on firms' carbon emissions. The analysis reveals greater reductions in CO_2 emissions by firms with more female managers with respect to their less inclusive counterparts after the signature of the treaty. Firms with greater gender diversity at the management level reduced carbon emissions by 5% more than did more male-oriented firms. Therefore, it appears that female managers play a crucial role in enhancing the implementation of climate-oriented policies, such as the Paris Agreement, by amplifying their transmission mechanism. Thus, policymakers should consider complementing climate policies with gender clauses advocating the inclusion of more women in managerial positions.

7. Conclusions

This paper investigates the relationship between the percentage of women appointed as managers and firms' carbon emissions. We first run a fixed-effects panel data regression on a sample of 1,951 listed companies in 24 industrialized economies over the period 2009-2019. Baseline results indicate that a 1% increase in female managers leads to a 0.5% decrease in CO_2 emissions. This effect is robust when controlling for institutional differences caused by culture and religion. At the same time, we show that gender diversity at the managerial level has stronger mitigating effects on climate change if females are also well-represented outside the organization, e.g. in political institutions and civil society organizations. Finally, we find that, after the Paris Agreement, firms with greater gender diversity in the workplace reduced CO_2 by about 5% more than firms which are more male-oriented.

Our consistent results about a negative and statistically significant relationship between the percentage of female managers and CO_2 emissions are supported by a solid theoretical framework grounded on the pro-environmental traits of female personalities, such as empathic behavior, social sensitivity and risk-aversion, which help female managers better contain the environmental impact of their decisions about how to implement the board's strategy, therefore achieving greater reductions in firm CO_2 emissions.

We, therefore, contribute to the literature on corporate gender diversity and CO_2 emissions by: i) delving into the role of female managers rather than only focusing on female directors; ii) extending on the literature quantitatively, as regards the number of firms and relative countries, and qualitatively, as regards the number of different sectors involved, the samples used so far by similar studies; iii) improving the granularity in the level of CO_2 emissions across firms by using firm-level data rather than the less informative indexes or indicators employed by similar studies; iv) drawing policy recommendations from the role played by female managers in the implementation of the Paris Agreement and COP26 deliberations as regards firms' carbon emissions reductions; and v) investigating the moderating role of institutional characteristics, such as higher female political engagement or community involvement, and cultural or religious barriers, such as the dominance of the male-breadwinner model and Catholicism, respectively, in increasing or limiting female managers' impact on CO_2 emissions.

Our results have important implications for both managers and policymakers. Regarding the former, we suggest that firms foster the inclusion of female managers in top management teams and also include green values in recruiting profile criteria. Regarding the latter, policies that envisage a larger percentage of women at the management level not only have an impact on gender diversity imbalances but allow for a more efficient fulfilment of the Paris Agreement recommendations. Policymakers can "kill two birds with one stone": more active engagement of women in the decision-making process may help achieve environmental objectives.

Finally, we suggest areas of further investigation based on the findings highlighted in this paper. It would be interesting to study the potential trade-off between the environmental results achieved by female managers and the corporate financial performance and risk due to a possible misalignment between the climate-related benefits and the financial repercussions that might stem the deployment of greener implementation strategies. In the context of emissions reductions, low-carbon investments such as low-carbon technologies are indeed more capital-intensive, which makes investment risk and funding costs more significant, and yield longer-term results than their high-carbon alternatives (Schmidt, 2014). For these reasons, investigating the financial performance implications for firms of female managers' pro-environmental views could disentangle the drivers of a firm's environmental commitment, contributing to a promising but scant strand of literature. Existing evidence indicates that the stock market values carbon emissions, as investors require higher compensation for holding the stocks of more polluting companies (Bolton and Kacperczyk, 2021). But further investigation is needed on the implications of carbon emissions for different profiles of corporate financial performance, such as firm value (Matsumura et al., 2014), risk (Kabir et al. 2021) and profitability (Clarkson et al. 2011), in order to disentangle the reasons underlying the deployment of strategies for reducing carbon emissions.

References

Abdallah, W., Goergen, M., and O'Sullivan, N. (2015). Endogeneity: How failure to correct for it can cause wrong inferences and some remedies. British Journal of Management, 26, 791-804.

Adams, R. B., and Funk, P. C. (2012). Beyond the glass ceiling: Does gender matter?. *Management Science, 58*, 219–235

Al-Tuwaijri, S. A., Christensen, T. E., and Hughes II, K. E. (2004). The relations among environmental disclosure, environmental performance, and economic performance: A simultaneous equations approach. *Accounting, Organizations and Society*, 29, 447-471.

Atif, M., Hossain, M., Samsul Alam, M. D., and Goergen, M. (2021). Does board gender diversity affect renewable energy consumption? *Journal of Corporate Finance*, 101665.

Barber, B. M., and Odean, T. (2001). Boys will be boys: Gender, overconfidence, and common stock investment. *Quarterly Journal of Economics*, 116, 261-292.

Ben-Amar, W., Chang, M. and McIlkenny, P. (2017). Board Gender Diversity and Corporate Response to Sustainability Initiatives: Evidence from the Carbon Disclosure Project. *Journal of Business Ethics, 142*, 369–383.

Berrone, P., and Gomez-Mejia, L.R. (2009). Environmental performance and executive compensation: An integrated agency-institutional perspective. *Academy of Management Journal, 52*, 103–126.

Bertrand, M., Duflo, E. and Mullainathan, S. (2004). "How much should we trust difference-indifferences estimates?", *Quarterly Journal of Economics*, No 119, pp. 249-275.

Bolton, P., and Kacperczyk M., (2021). Do Investors care about carbon risk?. *Journal of Financial Economics*, forthcoming.

Boone, A. L., Field, L. C., Karpoff, J. M., and Raheja, C. G. (2007). The determinants of corporate board size and composition: An empirical analysis. *Journal of Financial Economics*, 85, 66–101.

Bord, R. J., and O'Connor, R. E. (1997) The gender gap in environmental attitudes: The case of perceived vulnerability to risk. *Social Science Quarterly, 78*, 830-840.

Bugeja, M., Matolcsy, Z. P. and Spiropoulos, H. (2012). Is there a gender gap in CEO compensation?. *Journal of Corporate Finance, 18*, 849-859.

Byron, K., and Post, C. (2016). Women on boards of directors and corporate social performance: A meta-analysis. *Corporate Governance: An International Review, 24*, 428–442.

Chodorow, N. (1978). The reproduction of mothering: Psychoanalysis and the sociology of gender. Redwood City: Stanford University Press.

Clarkson, P. M., Li, Y., Richardson, G. D., and Vasvari, F. P. (2008). Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis. *Accounting, Organizations and Society*, 33, 303-327.

Clarkson P.M., Li Y., Richardson G.D., and Vasvari FP. (2011). Does it really pay to be green? Determinants and consequences of proactive environmental strategies. *Journal of Accounting and Public Policy 30*: 122-144.

Collins, C. (2019). *Can Improving Women's Representation in Environmental Governance Reduce Greenhouse Gas Emissions?*. Retrieved from: http://climate.org/wp-content/uploads/2019/02/WomenGhG2.pdf.

Coondoo, D., and Dinda, S. (2008). Carbon dioxide emission and income: A temporal analysis of cross-country distributional patterns. *Ecological Economics, 65*, 375-385.

Cragg, J., and Donald, S. 1993. Testing identifiability and specification in instrumental variables models. *Econometric Theory*, 9, 222-240.

Croson, R., and Gneezy, U. (2009). Gender Differences in Preferences. *Journal of Economic Literature, 47*, 448–474.

Davidson, D. J., and Freudenburg, W.R. (1996). Gender and environmental risk concerns a review and analysis of available research. *Environment and Behavior, 28*, 302–339.

Dawson, L. M. (1997). Ethical differences between men and women in the sales profession. *Journal of Business Ethics, 16*, 1143–1152.

Delis, M., De Greiff, K. and Ongena, S. (2018). "Being stranded on the carbon bubble? Climate policy risk and the pricing of bank loans", Swiss Finance Institute Research Paper Series, No 18-10, Swiss Finance Institute.

De Villiers, C., Naiker, V., and van Staden, C. J. (2011). The effect of board characteristics on firm environmental performance. *Journal of Management*, 37, 1636–1663.

Dietz, T. and Rosa, E. (1997). Effects of population and affluence on CO_2 emissions. *Proceedings of the National Academy of Sciences, 94*(1), 175-179.

Dietz, T., Kalof, L., and Stern, P. C. (2002). Gender, values, and environmentalism. *Social Science Quarterly, 83*, 353–364.

Eagly, A.H. (1987). Sex differences in social behavior: A social-role interpretation. New Jersey: Hillsdale.

Eagly, A.H., and Wood, W. (1991). Explaining sex differences in social behavior: A meta-analytic perspective. *Personality and Social Psychology Bulletin, 17*(3), 306–315.

Ergas, C. and York, R. (2012). Women's status and carbon dioxide emissions: A quantitative cross-national analysis. *Social Science Research, 41*, 965-976.

European Environmental Agency (2012), "Climate change, impacts and vulnerability in Europe", EEA Reports, No 12/2012.

Faccio, M., Marchica, M. T., and Mura, R. (2016). CEO gender, corporate risk-taking, and the efficiency of capital allocation. *Journal of corporate finance*, *39*, 193-209.

Fama, E.F., and Jensen, M.C. (1983). Agency problems and residual claims. *The Journal of Law and Economics,26*, 327–349.

Fernandez-Feijoo, B., Romero, S., and Ruiz-Blanco, S. (2014). Women on boards: Do they affect sustainability reporting? *Corporate Social Responsibility and Environmental Management, 21*(6), 351–364. https://doi.org/10.1002/csr.1329.

Franke, G.R., Crown, D.F., and Spake, D.F. (1997). Gender differences in ethical perceptions of business practices: A social role theory perspective. *Journal of Applied Psychology*, 82, 920.

Freeman, R.E. (1984). *Strategic management: A stakeholder perspective*. Englewood Cliffs, NJ: Prentice Hall.

Gonzalez, J.M., Jurado, T., and Naldini, M (1999). Introduction: Interpreting the transformation of gender inequalities in Southern Europe. *South European Society and Politics*, 4, 4-34.

Gonzalez-Gonzalez, J.M. and Ramírez, C.Z. (2016). Voluntary carbon disclosure by Spanish companies: an empirical analysis. *International Journal of Climate Change Strategies and Management, 8*, 57-79.

Granovetter, M. (1978). Threshold Models of Collective Behavior. *American Journal of Sociology, 83*, 1420–1443.

Greene, D., Intintolia, V.J., and Kahle, K. M. (2020). Do board gender quotas affect firm value? Evidence from California Senate Bill No. 826. *Journal of Corporate Finance, 60*, 101526.

Hambrick D.C. and Mason P.A. (1984). Upper echelons: the organization as a reflection of its top managers. *Academy of Management Review, 9*, 193–206.

Haque, F. (2017). The effects of board characteristics and sustainable compensation policy on carbon performance of UK firms. *British Accounting Review, 49*, 347–364.

Heider, F., Saidi, F., and Schepens, G. (2019). Life below zero: Bank lending under negative policy rates. *Review of Financial Studies*, 32, 3728-3761.

Hemingway, C. A. and Maclagan, P. W, (2004). Managers' personal values as drivers of corporate social responsibility. *Journal of Business Ethics, 50*, 33-44.

Homroy, S. and Mukherjee, S. (2021). The role of employer learning and regulatory interventions in mitigating executive gender pay gap. *Journal of Corporate Finance*, 101857.

Huang, J., and Kisgen, D. J. (2013). Gender and corporate finance: Are male executives overconfident relative to female executives? *Journal of Financial Economics*, *108*, 822-839.

Hussain, N., Rigoni, U., and Orij, R.P. (2018). Corporate governance and sustainability performance: Analysis of triple bottom line performance. *Journal of Business Ethics, 149*, 411–432.

Imbens, G.W. and Wooldridge, J.M. (2009). "Recent developments in the econometrics of program evaluation, *Journal of Economic Literature*, Vol. 47, No 1, pp. 5-86.

IPCC (2018). Summary for policymakers. Global warming of 1.5°C. An IPCC special report on the impact of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, Geneva.

Jensen, M.C., and Meckling, W.H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*, 305–360.

Jorgenson, A. (2007). Does foreign investment harm the air we breathe and the water we drink? A cross-national study of carbon dioxide emissions and organic water pollution in less-developed countries, 1975–2000. *Organization and Environment, 20*, 137–156.

Jorgenson, A. and Clark, B. (2009). The Economy, Military, and Ecologically Unequal Exchange Relationships in Comparative Perspective: A Panel Study of the Ecological Footprints of Nations, 1975–2000. *Social Problems, 56*, 621-646.

Kabir, M. N., Rahman, S., Rahman, M. A. and Anwar, M. (2021). Carbon emissions and default risk: International evidence from firm-level data. *Economic Modelling, 103*, 1-20.

Kanter, R. M. (1977a). *Men and Women of the Corporation.* New York: Basic Books.

Kanter, R. M. (1977b). Some Effects of Proportions on Group Life. *American Journal of Sociology 82*, 965-990.

Kanter, R. M. (1987). Men and Women of the Corporation Revisited. *Management Review 76*, 14–16.

Kurosaki, M. and Gao, K. (2020). *Gender Diversity and Climate Innovation.* Retrieved from: https://www.spf.org/en/global-data/BNEF_SPF_Gender_Climate_2.pdf.

Levi, M., Li, K., and Zhang, F. (2014). Director gender and mergers and acquisitions. *Journal of Corporate Finance*, *28*, 185-200.

Li, H. and Chen, P. (2018). Board gender diversity and firm performance: The moderating role of firm size. Journal of *Business Ethics, 27*, 294-308.

Liao, L., Luo, L. and Tang, Q. (2015). Gender diversity, board independence, environmental committee and greenhouse gas disclosure. *The British Accounting Review, 47*, 409-424.

Martin, C. JC and Herrero, B. (2020). Do board characteristics affect environmental performance? A study of EU firms. *Corporate Social Responsibility and Environmental Management*, 27, 74-94.

Matsumura, E.M., Prakash, R. and Vera-Munoz, S.C. (2014). Firm-Value Effects of Carbon Emissions and Carbon Disclosures. *The Accounting review, 89*, 695–724.

Mesonnier, J. S. (2019), Banks' climate commitments and credit to brown industries: new evidence for France, *Banque de France Working Papers*, No 743, Paris, November.

Mohai, P. (1992). Men, women, and the environment: An examination of the gender gap in environmental concern and activism. *Society and Natural Resources, 5*, 1–19.

Natby, K. F., and Rönnerfalk, H. (2018). *Gender Equality and CO_2 Emissions.* Retrieved from: http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=8934039&fileOId=8934040.

Nordhaus, W. D. (2019), "Climate change: The ultimate challenge for economics", *American Economic Review*, 109, 1991-2014.

Pew Research Center (2017). *Five Centuries After Reformation, Catholic-Protestant Divide in Western Europe Has Faded.* Retrieved from: https://www.pewforum.org/2017/08/31/five-centuries-after-reformation-catholic-protestant-divide-in-western-europe-has-faded/

Pfeffer, J., and Salancik, G. R. (1978). *The external control of organizations: A resource dependence approach*. New York: Harper and Row Publishers.

Post, C., Rahman, N., and Rubow, E. (2011). Green governance: Boards of directors' composition and environmental corporate social responsibility. *Business and Society*, 50, 189–223.

Prado-Lorenzo, JM and Garcia-Sanchez, IM (2010). The Role of the Board of Directors in Disseminating Relevant Information on Greenhouse Gases. *Journal of Business Ethics, 97*, 391–424.

Ravallion, M., Heil, M. and Jalan, J. (2000). Carbon emissions and income inequality. *Oxford Economic Papers, 52*, 651-669.

Reghezza, A., Altunbas, Y., Marques-Ibanez, D., Rogriguez d'Acri, C., and Spaggiari, M. (2020). Do banks fuel climate change? *ECB Working Paper Series*, n.2550, European Central Bank.

Rosenbaum P.R. and Rubin D.B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70, pp. 41-55.

Schmidt, T. S. (2014). Low-carbon investment risks and de-risking. *Nature Climate Change, 4*, 237-239.

Schopohl, L., Urquhart, A. and Zhang, H. (2020). Female CFOs, leverage and the moderating role of board diversity and CEO power. *Journal of Corporate Finance*, 101858.

Stock, J., and Yogo, M. (2005). Testing weak instruments in linear IV regression, Identification and inference for econometric models: Essays in honor of Thomas Rothenberg. *Cambridge University Press*, Cambridge, pp 80-108.

Sun, R. and Zou, G. (2021). Political connection, CEO gender, and firm performance. *Journal of Corporate Finance*, 101918.

Xiao, C., and McCright, A. M. (2007). Environmental concern and sociodemographic variables: A study of statistical models. *The Journal of Environmental Education, 38*, 3–14.

Xiao, C., and McCright, A. M. (2013). Gender differences in environmental concern: Revisiting the institutional trust hypothesis in the USA. *Environment and Behavior, 47*, 17–37.

Xiao, C., and McCright, A. M. (2014). A test of the biographical availability argument for gender differences in environmental behaviors. *Environment and Behavior, 46*, 241–263.

Yeganeh, H. (2021). A cross-national investigation into the effects of religion on gender equality. *International Journal of Sociology and Social Policy*, Vol. ahead-of-print No. ahead-of-print.

York, R. (2008). De-Carbonization in Former Soviet Republics, 1992–2000: The Ecological Consequences of De-Modernization. *Social Problems, 55*, 370-390.

York, R., Rosa, E. and Dietz, T. (2003). STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts. *Ecological Economics, 46*, 351-365.

Zelezny, L. C., Chua, P.-P., and Aldrich, C. (2000). New ways of thinking about environmentalism: Elaborating on gender differences in environmentalism. *Journal of Social Issues, 56*, 443–457.

Figure 1. Correlation between firm female managers and CO_2 emissions

This figure shows the correlation between the % of female managers (y-axis) and the logarithm of CO_2 emissions (x-axis). The downward-sloping red line represents the fitted values obtained from regressing the % of female managers and CO_2 emissions. 95% confidence interval are reported in grey.

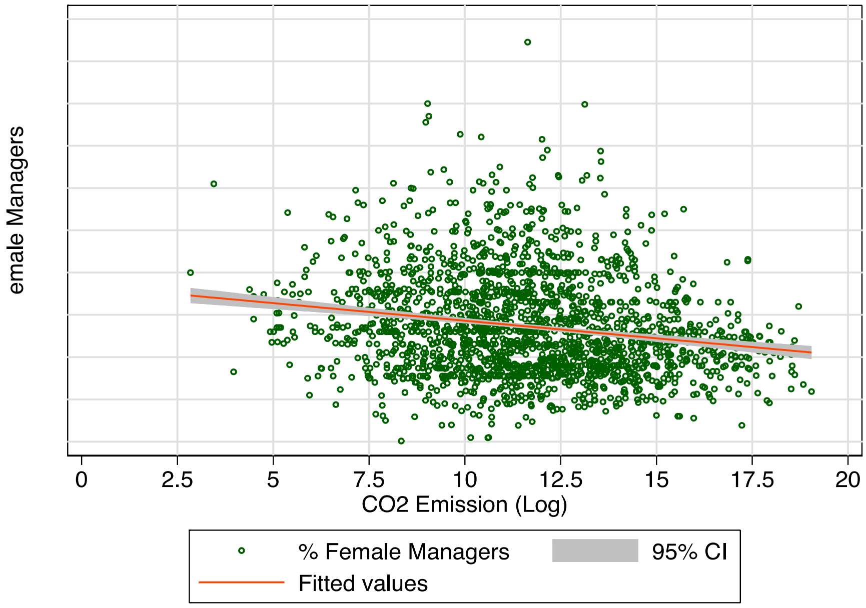

Figure 2. Box Plot

The box plot displays the % of female managers (x-axis) by sector. The box shows the interquartile range (first quartile, median, third quartile) and upper and lower whisker.

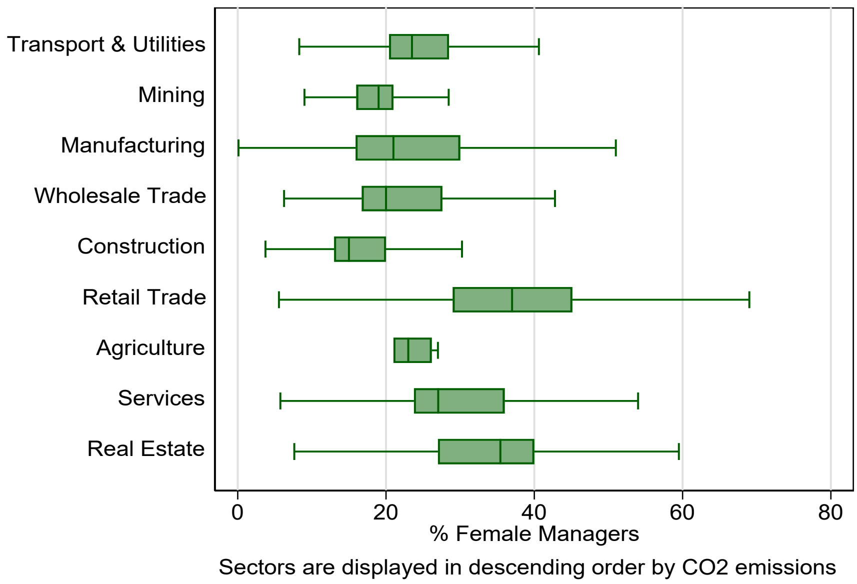

Figure 3. Percentage of females in the labor force in Northern and Southern countries

This figure shows the percentage of female in the labor force – weighted on the overall labor force – (y axis) by Northern (green bar) and Southern (yellow bar) countries. Welch t-test for difference in means between the two groups is displayed and statistically significant at the 1% level. Southern countries are Greece, Italy, Portugal, Spain and Turkey while Northern countries is represented by the remaining countries in the sample.

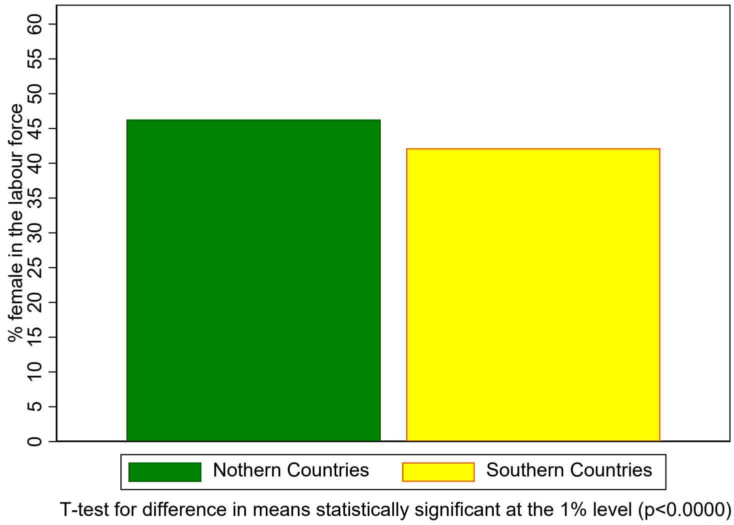

Figure 4. Percentage of Catholics by country

This figure reports the percentage of Catholics (y axis) over total population by country. Bar charts are displayed in descending order.

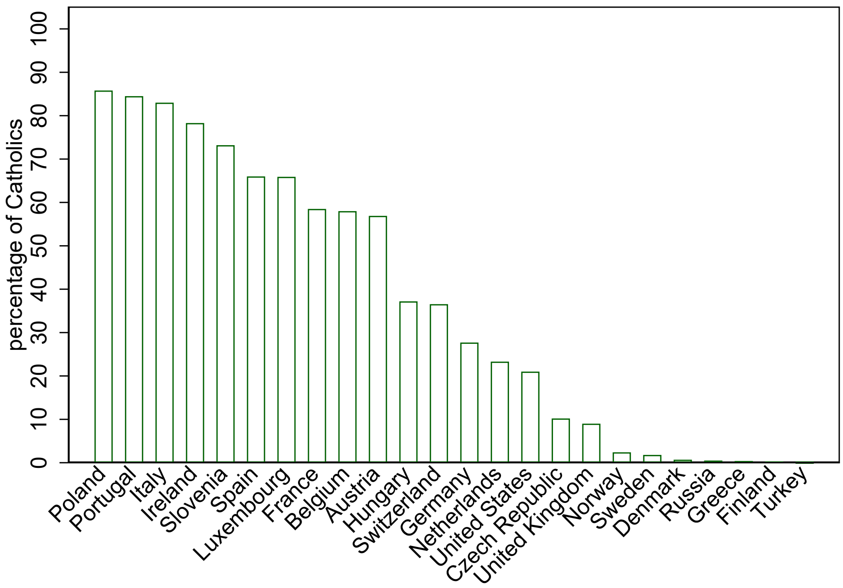

Figure 5. Trends in CO2 emissions

The left chart shows the mean level of CO_2 emissions in logarithm divided by the treated and control group prior to the Paris Agreement (2009-2015). The right chart displays the normalized median level of CO_2 emissions measured in tonnes divided by the treated and control group prior and after the Paris Agreement. The green line represents firms with an above-median percentage of female managers (treated group) prior to the Agreement whilst the orange line indicates firms with a below-median percentage of female managers (control group) prior to the Agreement. The dashed vertical line indicates the introduction of the Accord.

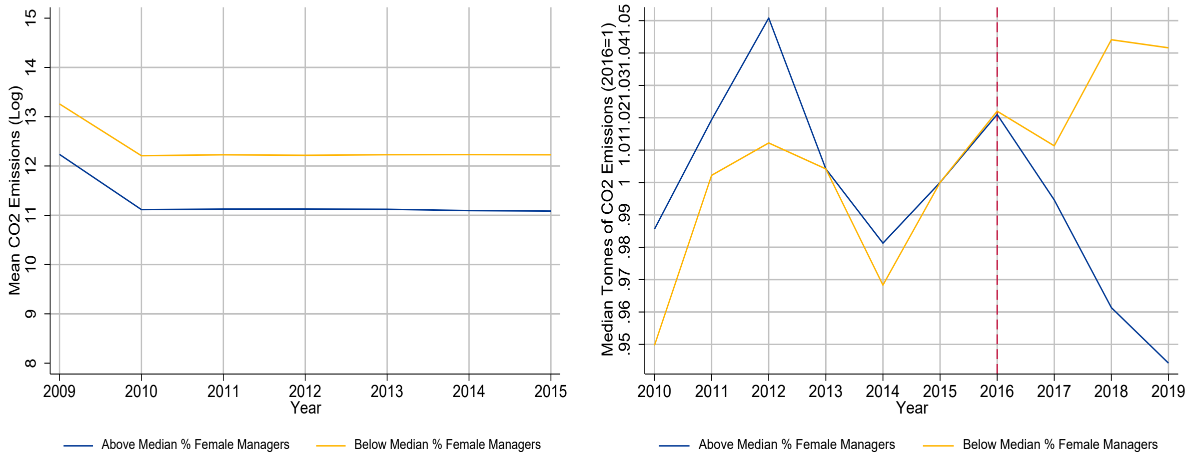

Figure 6. Difference-in-differences dynamic coefficients plot

This figure plots the dynamic coefficients of the DiD estimation from two years prior to two years after the Paris Accord. The solid blue line represents the estimated DiD coefficients for the control group (i.e. firms with a below-median level of female managers) whilst the yellow dashed line the estimated DiD coefficients for the treatment group (i.e. firms with an above-median level of female senior managers). The vertical dashed red line indicates the introduction of the Paris Accord. The shaded grey areas indicate 95% confidence interval.

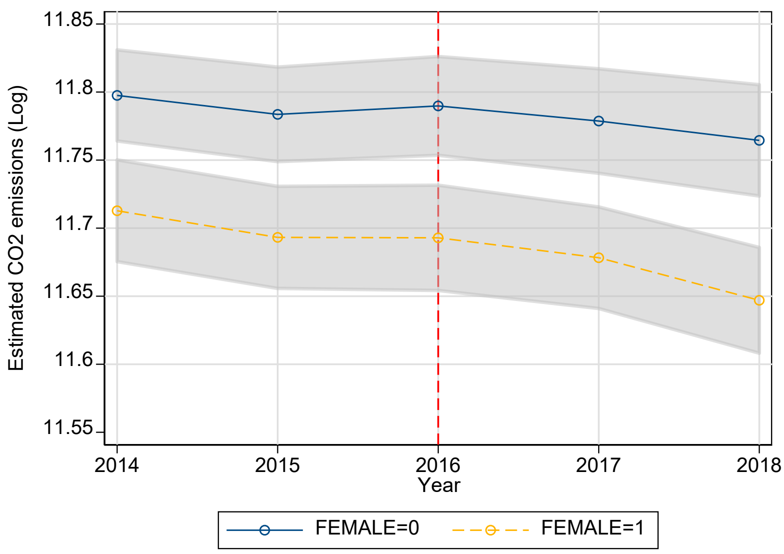

Figure 7. The kernel density function for treated and control group pre-post propensity score matching

This figure shows kernel density function (y-axis) for the treated and control group and propensity scores (x-axis) before and after matching.

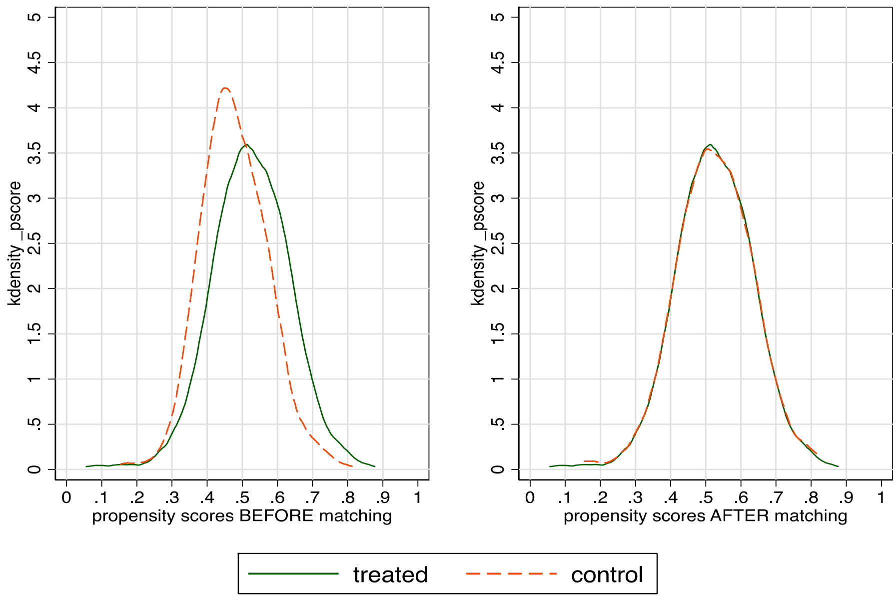

Table 1. Number of firms by country and sector

Country	N.Firms	Number of Firms by Sector								
		AG	CN	FN	MF	MG	RT	SV	TP	WS
Austria	32		2	9	16				5	
Belgium	33		2	10	11		1	2	7	
Czech Republic	2								2	
Denmark	35			7	19			2	6	1
Finland	33		3	4	16		2	3	3	2
France	131	1	3	23	43	6	8	29	15	3
Germany	126		2	18	67	1	5	10	17	6
Greece	18		4	5	3			1	5	
Hungary	3			1	1				1	
Ireland	17	1		3	7	1		1	1	3
Italy	93		3	25	37	1	1	4	19	3
Luxembourg	10			1	4	1		1	3	
Netherlands	53		4	12	20	5	2	5	4	1
Norway	52	1	1	10	17	9	3	2	8	1
Poland	26		1	6	7	1	1	1	7	2
Portugal	15		1	1	5		2		6	
Russia	38	1		3	8	10	1	1	14	
Slovenia	1				1					
Spain	64		9	15	18		2	8	12	
Sweden	100	1	5	20	46	1	5	13	7	2
Switzerland	72		2	19	38		1	7	5	
Turkey	40	1	2	9	16		4		7	1
United Kingdom	358		18	83	84	27	40	59	36	11
United States	599	1	4	89	270	30	35	70	82	18
Total	1951	7	66	373	754	93	113	219	272	54

Notes: AG "Agriculture, Forestry and Fishing"; CN "Construction"; FN "Finance, Insurance and Real Estate"; MF "Manufacturing"; MG "Mining"; RT "Retail Trade"; SV "Services"; TP "Transportation and Public Utilities"; WS "Wholesale Trade".

Table 2. Descriptive CO_2 emissions (in tonnes) by sector

Sector	Obs	Mean	STD	Min	Max
Agriculture, Forestry and Fishing	71	420,066	462,339	19,900	1,225,000
Construction	693	1,124,179	4,458,301	629	45,700,000
Finance, Insurance and Real Estate	3,877	128,527	836,808	13.9	26,400,000
Manufacturing	7,882	2,592,686	11,700,000	29	195,000,000
Mining	967	6,056,506	14,000,000	633.6	86,000,000
Retail Trade	1,180	92,285	2,375,368	89	21,900,000
Services	2,259	249,343	1,007,534	31.5	16,300,000
Transportation and Public Utilities	2,861	11,100,000	24,200,000	275	184,000,000
Wholesale Trade	553	1,158,392	4,583,799	1,231	34,400,000
Total	20,343	3,035,824	12,600,000	13.9	195,000,000

Table 3. Descriptive Statistics

	Obs	Mean	STD	Min	Max
Panel A. Dependent Variables					
logCO2	20,343	11.69	2.74	2.63	19.08
CO2_TA	20,321	10.02	15.39	0.05	47.47
Panel A. Corporate Governance Variables					
%FManagers	21,373	27.23	12.49	0.09	94.78
Board_Size	21,417	4.79	2.42	3.00	31.00
Board_Diversity	21,417	23.39	11.42	3.85	75.00
Exp_Board	21,417	6.76	3.25	0.04	23.03
Ind_Board	21,386	63.96	22.90	0.00	100
Panel B. Firm Balance Sheet Variables					
Size (log)	21,439	15.55	1.85	4.28	21.82
Size ($ billions)	21,439	44.90	193.00	0.72	3,000
Debt_Ta	21,318	27.49	17.97	0.01	99.21
CSR	20,344	49.82	27.26	0.02	99.88
Cashfl_Sales	21,406	16.85	18.67	-190.83	196.46
RoA	21,439	5.75	8.14	-90.85	99.30
BVPS	21,461	3.24	5.63	0.01	97.19
Beta	21,461	1.03	0.56	0.00	4.95

Notes: LogCO2 is the logarithm of CO_2 emissions. CO2_TA is the ratio of CO_2 emissions-to-total assets. %FManagers is the percentage of female managers to the total number of managers. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta.

Table 4. Baseline Result

VARIABLES	(1) logCO2	(2) logCO2	(3) logCO2
%Fmanagers	**-0.0056***** **(0.002)**	**-0.0058***** **(0.002)**	**-0.0048**** **(0.002)**
Board_size	-0.0021 (0.006)	-0.0014 (0.006)	0.0003 (0.006)
Board_diversity	0.0008 (0.001)	0.0008 (0.001)	0.0015 (0.001)
Exp_board	0.0167*** (0.005)	0.0166*** (0.005)	0.0126** (0.005)
Ind_board	-0.0004 (0.001)	-0.0002 (0.001)	-0.0011* (0.001)
L.Size	0.2966*** (0.026)	0.3162*** (0.026)	0.2238*** (0.028)
L.Debt_ta	-0.0007 (0.001)	-0.0010 (0.001)	-0.0007 (0.001)
L.CSR_score	0.0009** (0.000)	0.0010** (0.000)	0.0005 (0.000)
L.cashfl_sales	-0.0001 (0.000)	-0.0002 (0.000)	0.0001 (0.000)
L.ROA	-0.0005 (0.001)	-0.0005 (0.001)	-0.0006 (0.001)
L.BVPS	-0.0010 (0.001)	-0.0007 (0.001)	-0.0007 (0.001)
L.Beta	0.0443** (0.018)	0.0478*** (0.018)	0.0259 (0.018)
Observations	18,161	18,161	18,161
Number of firms	1,910	1,910	1,910
Industry FE	Yes	No	No
Sub-industry FE	No	Yes	No
Firm FE	No	No	Yes
Time FE	Yes	Yes	No
Country-time FE	No	No	Yes

Notes: Log_CO_2 is the logarithm of CO_2 emissions. %FManager is the percentage of female managers to the total number of managers. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 5. Culture, religion, female managers and CO_2 emissions

VARIABLES	(1) logCO2	(2) logCO2	(3) logCO2	(4) logCO2	(5) logCO2	(6) logCO2
%Fmanagers	**-0.0059****	**-0.0063*****	**-0.0050****	**-0.0063****	**-0.0065*****	**-0.0034**
	(0.002)	**(0.002)**	**(0.002)**	**(0.003)**	**(0.003)**	**(0.003)**
South*%Fmanagers	**0.0017**	**0.0029**	**0.0016**			
	(0.004)	**(0.004)**	**(0.004)**			
Catholics*%Fmanagers				**0.0008**	**0.0009**	**-0.0026**
				(0.004)	**(0.004)**	**(0.004)**
Board_size	-0.0019	-0.0011	0.0002	-0.0029	-0.0025	0.0003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Board_diversity	0.0008	0.0008	0.0015	0.0008	0.0008	0.0015
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Exp_board	0.0166***	0.0165***	0.0126**	0.0152***	0.0148***	0.0127**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Ind_board	-0.0004	-0.0003	-0.0011*	-0.0006	-0.0004	-0.0011*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.Size	0.2965***	0.3149***	0.2237***	0.2879***	0.3059***	0.2238***
	(0.026)	(0.026)	(0.028)	(0.026)	(0.026)	(0.028)
L.Debt_ta	-0.0007	-0.0010	-0.0007	-0.0007	-0.0010	-0.0007
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.CSR_score	0.0009*	0.0010**	0.0005	0.0010**	0.0010**	0.0005
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.cashfl_sales	-0.0001	-0.0002	0.0001	-0.0001	-0.0002	0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.ROA	-0.0005	-0.0005	-0.0006	-0.0004	-0.0004	-0.0005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.PB	-0.0010	-0.0007	-0.0007	-0.0010	-0.0007	-0.0007
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.Beta	0.0442**	0.0473***	0.0259	0.0429**	0.0462**	0.0263
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Observations	18,161	18,161	18,161	18,161	18,161	18,161
Number of firms	1,910	1,910	1,910	1,910	1,910	1,910
Industry FE	Yes	No	No	Yes	No	No
Sub-industry FE	No	Yes	No	No	Yes	No
Firm FE	No	No	Yes	No	No	Yes
Time FE	Yes	Yes	No	Yes	Yes	No
Country-time FE	No	No	Yes	No	No	Yes

Notes: Log_CO_2 is the logarithm of CO_2 emissions. %FManager is the percentage of female managers to the total number of managers. South is a dummy variable that takes the value 1 if a country is located in southern Europe, 0 otherwise. Catholic is a dummy variable that takes the value 1 if a country has an above-median level of Catholics over the total population. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 6. Institutional variables, female managers and CO_2 emissions

VARIABLES	(1) logCO2	(2) logCO2	(3) logCO2	(2) logCO2	(3) logCO2	(2) logCO2
%Fmanagers	**-0.0040***	**-0.0042****	**-0.0033**	**-0.0045****	**-0.0047****	**-0.0034**
	(0.002)	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**	**(0.002)**
CSOW*%Fmanagers	**-0.0023*****	**-0.0023*****	**-0.0022****			
	(0.001)	**(0.001)**	**(0.001)**			
ElectedW *%Fmanagers				**-0.0017***	**-0.0017***	**-0.0021****
				(0.001)	**(0.001)**	**(0.001)**
Board_size	-0.0021	-0.0014	0.0003	-0.0020	-0.0013	0.0004
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Board_diversity	0.0008	0.0008	0.0016	0.0008	0.0008	0.0015
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Exp_board	0.0168***	0.0166***	0.0126**	0.0167***	0.0166***	0.0126**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Ind_board	-0.0003	-0.0002	-0.0011	-0.0004	-0.0002	-0.0011*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.Size	0.2962***	0.3159***	0.2237***	0.2987***	0.3196***	0.2235***
	(0.025)	(0.026)	(0.028)	(0.025)	(0.026)	(0.028)
L.Debt_ta	-0.0008	-0.0011	-0.0007	-0.0008	-0.0011	-0.0007
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.CSR_score	0.0009**	0.0010**	0.0005	0.0009**	0.0010**	0.0005
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.cashfl_sales	-0.0002	-0.0002	0.0000	-0.0002	-0.0002	0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
L.ROA	-0.0005	-0.0005	-0.0006	-0.0005	-0.0005	-0.0006
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.PB	-0.0009	-0.0007	-0.0007	-0.0010	-0.0007	-0.0007
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.Beta	0.0442**	0.0477***	0.0254	0.0452**	0.0490***	0.0265
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Observations	18,161	18,161	18,161	18,161	18,161	18,161
Number of firms	1,910	1,910	1,910	1,910	1,910	1,910
Industry FE	Yes	No	No	Yes	No	No
Sub-industry FE	No	Yes	No	No	Yes	No
Firm FE	No	No	Yes	No	No	Yes
Time FE	Yes	Yes	No	Yes	Yes	No
Country-time FE	No	No	Yes	No	No	Yes

Notes: Log_CO_2 is the logarithm of CO_2 emissions. %FManager is the percentage of female managers to the total number of managers. ElectedW is a dummy variable that takes the value 1 if a country has an above-median score in terms of percentage of female ministers elected during the last elections. COSW is a dummy variable that takes the value 1 if a country has an above-median score in terms of the degree of women participation in civil society organization. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 7. Difference-in-differences results

VARIABLES	(1) logCO2	(2) logCO2	(3) logCO2
PA	-0.0691***	-0.0709***	0.0514
	(0.019)	(0.019)	(0.073)
FEMALE	-0.3241***	-0.2994***	
	(0.105)	(0.108)	
PA*FEMALE	**-0.0572*** **	**-0.0586*** **	**-0.0499** **
	(0.021)	**(0.021)**	**(0.021)**
Board_size	-0.0023	-0.0017	0.0000
	(0.006)	(0.006)	(0.006)
Board_diversity	0.0007	0.0007	0.0014
	(0.001)	(0.001)	(0.001)
Exp_board	0.0170***	0.0168***	0.0129**
	(0.005)	(0.005)	(0.005)
Ind_board	-0.0004	-0.0002	-0.0011*
	(0.001)	(0.001)	(0.001)
L.Size	0.2998***	0.3186***	0.2266***
	(0.026)	(0.026)	(0.028)
L.Debt_ta	-0.0007	-0.0010	-0.0008
	(0.001)	(0.001)	(0.001)
L.CSR_score	0.0009*	0.0009**	0.0005
	(0.000)	(0.000)	(0.000)
L.cashfl_sales	-0.0001	-0.0002	0.0001
	(0.000)	(0.000)	(0.000)
L.ROA	-0.0004	-0.0004	-0.0005
	(0.001)	(0.001)	(0.001)
L.PB	-0.0008	-0.0006	-0.0006
	(0.001)	(0.001)	(0.001)
L.Beta	0.0437**	0.0474***	0.0258
	(0.018)	(0.018)	(0.018)
Observations	18,198	18,198	18,198
Number of firms	1,914	1,914	1,914
Industry FE	Yes	No	No
Sub-industry FE	No	Yes	No
Firm FE	No	No	Yes
Time FE	Yes	Yes	No
Country-time FE	No	No	Yes

Notes: $LogCO_2$ is the logarithm of CO_2 emissions. FEMALE is a dummy variable that takes the value 1 if a firm has an above-median percentage of female managers prior to the Paris Agreement (2015), 0 otherwise. PA is a dummy variable that takes the value 1 after the Paris Agreement, 0 otherwise. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level

Table 8. Results continuous Interaction

VARIABLES	(1) logCO2	(2) logCO2	(3) logCO2
PA	-0.0243	-0.0257	0.0826
	(0.028)	(0.028)	(0.075)
%Fmanagers	**-0.0046****	**-0.0047****	**-0.0039***
	(0.002)	**(0.002)**	**(0.002)**
PA*%Fmanagers	**-0.0024*****	**-0.0025*****	**-0.0019****
	(0.001)	**(0.001)**	**(0.001)**
Board_size	-0.0020	-0.0013	0.0003
	(0.006)	(0.006)	(0.006)
Board_diversity	0.0009	0.0009	0.0016
	(0.001)	(0.001)	(0.001)
Exp_board	0.0168***	0.0167***	0.0128**
	(0.005)	(0.005)	(0.005)
Ind_board	-0.0004	-0.0002	-0.0011*
	(0.001)	(0.001)	(0.001)
L.Size	0.2981***	0.3176***	0.2248***
	(0.026)	(0.026)	(0.028)
L.Debt_ta	-0.0008	-0.0011	-0.0008
	(0.001)	(0.001)	(0.001)
L.CSR_score	0.0009**	0.0010**	0.0005
	(0.000)	(0.000)	(0.000)
L.cashfl_sales	-0.0001	-0.0002	0.0001
	(0.000)	(0.000)	(0.000)
L.ROA	-0.0005	-0.0005	-0.0006
	(0.001)	(0.001)	(0.001)
L.PB	-0.0009	-0.0006	-0.0007
	(0.001)	(0.001)	(0.001)
L.Beta	0.0438**	0.0473***	0.0255
	(0.018)	(0.018)	(0.018)
Observations	18,161	18,161	18,161
Number of firms	1,910	1,910	1,910
Industry FE	Yes	No	No
Sub-industry FE	No	Yes	No
Firm FE	No	No	Yes
Time FE	Yes	Yes	No
Country-time FE	No	No	Yes

Notes: Log_CO_2 is the logarithm of CO_2 emissions. %FManager is the percentage of female managers to the total number of managers. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 9. Difference-in-differences propensity score matching

	(1)	(2)	(3)
VARIABLES	logCO2	logCO2	logCO2
PA	-0.0527**	-0.0551**	0.0437
	(0.025)	(0.025)	(0.067)
FEMALE	-0.3486***	-0.3074**	
	(0.131)	(0.135)	
PA*FEMALE	**-0.0764*** **	**-0.0780*** **	**-0.0664** **
	(0.026)	**(0.026)**	**(0.026)**
Board_size	-0.0063	-0.0057	-0.0032
	(0.007)	(0.007)	(0.007)
Board_diversity	0.0008	0.0008	0.0017
	(0.001)	(0.001)	(0.001)
Exp_board	0.0202***	0.0198***	0.0140**
	(0.006)	(0.006)	(0.006)
Ind_board	-0.0006	-0.0004	-0.0015*
	(0.001)	(0.001)	(0.001)
L.Size	0.3075***	0.3292***	0.2326***
	(0.030)	(0.030)	(0.033)
L.Debt_ta	-0.0012	-0.0015	-0.0011
	(0.001)	(0.001)	(0.001)
L.CSR_score	0.0008	0.0009	0.0003
	(0.001)	(0.001)	(0.001)
L.cashfl_sales	0.0001	-0.0000	0.0002
	(0.000)	(0.000)	(0.000)
L.ROA	-0.0012	-0.0012	-0.0010
	(0.001)	(0.001)	(0.001)
L.PB	-0.0007	-0.0005	-0.0005
	(0.001)	(0.001)	(0.001)
L.Beta	0.0444**	0.0493**	0.0240
	(0.021)	(0.021)	(0.022)
Observations	13,833	13,833	13,833
Number of firms	1,455	1,455	1,455
Industry FE	Yes	No	No
Sub-industry FE	No	Yes	No
Firm FE	No	No	Yes
Time FE	Yes	Yes	No
Country-time FE	No	No	Yes

Notes: LogCO_2 is the logarithm of CO_2 emissions. FEMALE is a dummy variable that takes the value 1 if a firm has an above-median percentage of female managers prior to the Paris Agreement (2015), 0 otherwise. PA is a dummy variable that takes the value 1 after the Paris Agreement, 0 otherwise. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 10. Placebo test

VARIABLES	(1) logCO2	(2) logCO2	(3) logCO2
"Fake" PA	-0.0615***	-0.0664***	0.0303
	(0.016)	(0.016)	(0.075)
FEMALE	-0.3115***	-0.3171***	
	(0.102)	(0.103)	
"Fake" PA*FEMALE	**-0.0228**	**-0.0240**	**-0.0186**
	(0.020)	**(0.021)**	**(0.020)**
Board_size	0.0092	0.0108*	0.0050
	(0.007)	(0.007)	(0.007)
Board_diversity	-0.0028**	-0.0029**	-0.0013
	(0.001)	(0.001)	(0.001)
Exp_board	0.0101*	0.0099*	0.0039
	(0.006)	(0.006)	(0.007)
Ind_board	0.0009	0.0011*	-0.0002
	(0.001)	(0.001)	(0.001)
L.Size	0.4056***	0.4444***	0.1370***
	(0.028)	(0.029)	(0.029)
L.Debt_ta	-0.0011	-0.0020*	-0.0012
	(0.001)	(0.001)	(0.001)
L.CSR_score	0.0023***	0.0022***	0.0012*
	(0.001)	(0.001)	(0.001)
L.cashfl_sales	0.0001	0.0000	0.0007
	(0.001)	(0.001)	(0.000)
L.ROA	-0.0026*	-0.0026*	-0.0020
	(0.002)	(0.002)	(0.001)
L.PB	-0.0019	-0.0013	-0.0023
	(0.001)	(0.001)	(0.002)
L.Beta	0.0941***	0.1048***	0.0373
	(0.025)	(0.025)	(0.025)
Observations	8,646	8,646	8,646
Number of firms	1,914	1,914	1,914
Industry FE	Yes	No	No
Sub-industry FE	No	Yes	No
Firm FE	No	No	Yes
Time FE	Yes	Yes	No
Country-time FE	No	No	Yes

Notes: LogCO_2 is the logarithm of CO_2 emissions. FEMALE is a dummy variable that takes the value 1 if a firm has an above-median percentage of female managers prior to the "fake" Paris Agreement (2011), 0 otherwise. "Fake" PA is a dummy variable that takes the value 1 after the "fake" Paris Agreement (2012), 0 otherwise. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 11. Results with CO2 emission intensity

VARIABLES	(1) CO2_TA	(2) CO2_TA	(3) CO2_TA
%Fmanagers	**-0.0227****	**-0.0230****	**-0.0202***
	(0.011)	**(0.011)**	**(0.012)**
Board_size	-0.0662	-0.0619	-0.0625
	(0.067)	(0.066)	(0.067)
Board_diversity	0.0038	0.0040	-0.0079
	(0.009)	(0.009)	(0.008)
Exp_board	0.1197**	0.1206**	0.1349**
	(0.053)	(0.052)	(0.056)
Ind_board	0.0024	0.0038	-0.0026
	(0.007)	(0.007)	(0.007)
L.Size	-2.2598***	-2.2348***	-3.0649***
	(0.263)	(0.257)	(0.294)
L.Debt_ta	-0.0058	-0.0059	-0.0034
	(0.008)	(0.008)	(0.007)
L.CSR_score	0.0058	0.0056	-0.0005
	(0.004)	(0.004)	(0.004)
L.cashfl_sales	-0.0029	-0.0028	-0.0010
	(0.003)	(0.003)	(0.003)
L.ROA	-0.0338***	-0.0330***	-0.0309***
	(0.011)	(0.011)	(0.011)
L.PB	0.0090	0.0105	0.0057
	(0.010)	(0.010)	(0.010)
L.Beta	0.6139***	0.6333***	0.5788***
	(0.193)	(0.194)	(0.187)
Constant	46.5714***	52.5500***	57.8796***
	(8.575)	(10.740)	(4.632)
Observations	18,161	18,161	18,161
Number of firms	1,910	1,910	1,910
Industry FE	Yes	No	No
Sub-industry FE	No	Yes	No
Firm FE	No	No	Yes
Time FE	Yes	Yes	No
Country-time FE	No	No	No

Notes: CO2_TA is the ratio of CO_2 emissions to firm total assets. %FManager is the percentage of female managers to the total number of managers. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Table 12. IV Regression

VARIABLES	(1) %Fmanagers	(2) logCO2
Womenpart	**0. 2495***** **(0.037)**	
%Fmanagers-fitted		**-0.0393**** **(0.016)**
Board_size	0.0027 (0.035)	-0.0026 (0.003)
Board_diversity	0.0274*** (0.057)	0.0019** (0.000)
Exp_board	-0.0246 (0.026)	0.0156*** (0.003)
Ind_board	0.0012 (0.003)	-0.0009* (0.000)
L.Size	-0.1552 ** (0.072)	0.1878*** (0.014)
L.Debt_ta	-0.0043 (0.002)	-0.0007 (0.000)
L.CSR_score	0.0088*** (0.002)	0.0005 (0.000)
L.cashfl_sales	0.0021 (0.002)	-0.0005 (0.000)
L.ROA	-0.0073 (0.004)	-0.0005 (0.000)
L.PB	0.0147** (0.005)	-0.0007 (0.000)
L.Beta	0.0574 (0.109)	0.0375 (0.011)
Observations	18,161	18,161
Number of firms	1,910	1,910
Firm FE	Yes	Yes
Time FE	Yes	Yes
Kleibergen-Paap rk LM statistic	43.80	
Cragg-Donald Wald F-statistic	58.20	
Stock-Yogo weak ID test critical values at 10% IV size	16.38	

Notes: Log_CO_2 is the logarithm of CO_2 emissions. %FManager is the percentage of female managers to the total number of managers. Womenpart is the percentage of female participation in the labor force over male participation. Board_Size is the number of directors elected to the board. Board_Diversity is the fraction of female board members over the total number of members. Exp_Board is the percentage of board members who have either an industry-specific background or a strong financial background. Ind_Board the percentage of independent board members in the company. Size is the logarithm (or billions) of firm total assets. Debt_Ta is the ratio of debt-to-total assets. CSR is the corporate social responsibility score. Cashfl_Sales is the ratio of cash flow-to-sales. RoA is the return on assets. BVPS is the book value per share. Beta is the historical beta. Robust standard errors clustered at the firm level reported in parentheses. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.