

Article

Gender and Climate Change Disclosure: An Interdimensional Policy Approach

Melsa Ararat ^{1,*} and Borhan Sayedy ²

¹ Corporate Governance Forum, School of Management, Sabancı University, Istanbul 34956, Turkey

² School of Management, Sabancı University, Istanbul 34956, Turkey; borhansayed@sabanciuniv.edu

* Correspondence: melsaararat@sabanciuniv.edu; Tel.: +90-2164839713

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Abstract: This paper investigates the impact of corporate boards' gender diversity on voluntary public disclosure of climate change risks in an emerging economy context in which environmental regulations are weak and markets are ineffective. The investigation relies on data from the CDP (formerly known as the Carbon Disclosure Project) as a corporate sustainability reporting initiative supported by institutional investors, based on a sample of Turkish firms that were invited to disclose their climate change risks and greenhouse gas emissions over the period of 2010–2019 through the CDP platform. We report that the presence of women on board committees, as a proxy for their active involvement in corporate governance, increases the likelihood of voluntary climate change disclosure. We, on the other hand, found no evidence of a positive impact on climate change reporting with women's overall representation in boards. These findings lend support to board reforms that aim to increase *effective* representation of women on boards for the better management of sustainability risks and responsiveness to stakeholder demands in countries where legislators are reluctant to introduce climate change reforms.

Keywords: climate change disclosure; boards of directors; corporate governance; gender diversity; controlled firms; emerging economies

1. Introduction

Climate change is defined as one of the most important risks threatening life on Earth, and is a major impediment to economic and social development [1,2]. Since climate change is highly correlated with the greenhouse gas emissions from energy production that is vital for economic and social development, it presents the “greatest challenge of our time”; staying within planetary boundaries while pursuing long-term social and economic development [3]. This challenge is greater for developing economies (See the special issue on Development Under Climate Change of Review of Development Economics, 16(3), 2012, for a comprehensive analysis and the recent discussions at the United Nations' Economic and Financial Committee on the unprecedented impacts of climate change disproportionately burdening developing countries available at <https://www.un.org/press/en/2019/gaef3516.doc.htm>).

Despite the seriousness of the climate change threat, implementation of intergovernmental policy agreements and legislative responses, reflected in UN 2030 Agenda for Sustainable Development (<https://sustainabledevelopment.un.org/post2015/transformingourworld>) in 2015 and the milestone Paris Agreement (See conclusions agreed in December 2015 at http://unfccc.int/paris_agreement/items/9485.php), have so far come up short of setting a trajectory path that would limit global warming to 1.5 °C, beyond which catastrophic events will become inevitable. As a response, a number of global initiatives have focused on mobilizing market actors, namely companies and investors (See ICGN's Viewpoint on Systemic Risks at

<https://www.icgn.org/policy/viewpoints/investor-framework-addressing-systemic-risks>). These efforts reflect a concern about the market failure in pricing unsustainability and regulatory capture by interest groups [4].

On the regulatory front, the preferred approach has also shifted towards incentivising and mobilising private actors and market mechanisms. In May 2018, the European Commission [5] presented a package of measures as a follow-up to its action plan on financing sustainable growth. The package focuses predominantly on capital markets in order to support the better allocation of financial capital to companies and projects that are sustainable. A key instrument proposed in the action plan is regulatory disclosure of environmental, social and governance risks by companies as well as charging institutional investors with the fiduciary duty of taking this information into consideration in investment decisions. The Commission specifically mentions “fostering sustainable corporate governance”, with no further elaboration on what this actually means and how it is related to climate change. While certain corporate disclosures related to climate change may be mandatory in some countries to help the allocation of capital to more sustainable companies, discretionary reporting has become an important matter of governance. Climate change poses physical (operational), financial and reputational risks for companies. Detecting climate change-related risks, developing strategies to manage them and disclosing those risks and risk management strategies are an essential part of boards’ fiduciary duties (See G20-OECD Corporate Governance Principles at https://www.oecd-ilibrary.org/governance/g20-oecd-principles-of-corporate-governance-2015_9789264236882-en).

In this context, companies are exposed to stakeholder pressures to disclose their carbon emissions and climate change strategies, while institutional investors are also under pressure by asset owners, especially by pension funds, to adopt better stewardship policies and take into account the materiality of climate change risks when making investment decisions [6,7]. In response to these pressures, the number of companies that voluntarily disclose climate change information beyond the regulatory requirements has been increasing. Our research addresses the Commission’s shortcomings by investigating the role of boards’ gender diversity as a board attribute that may have an impact on voluntary climate change disclosure channelled through the better functioning of boards’ audit and risk management committees. These committees are mandatory in most jurisdictions. Our inquiry is more relevant for developing economies, where governments are concerned about the conflicts between growth and climate change regulations and are therefore reluctant to introduce climate change reforms [8].

Companies are disclosing climate change information through general-purpose corporate social responsibility (CSR) or sustainability reports, and increasingly through the CDP (Carbon Disclosure Project)—a charity founded in London in 2000 with the backing of international institutional investors. Each year, the CDP invites the largest listed companies around the world on behalf of signatory investors to disclose their carbon emissions and detail how they manage the risks and opportunities that stem from climate change. As of 2018, the number of companies that disclosed climate change information in response to the CDP’s invitation was over 7000, representing 56% of the total global market cap (See CDP’s website for data at <https://www.cdp.net/en/data>). Some rating agencies that provide environmental, social and governance (ESG) ratings to institutional investors and index builders use CDP data in their own assessments. The failure of regulatory approaches to mitigate climate change makes it important to understand the drivers for companies to disclose climate change information that may have implications on sustainable investing.

In the corporate governance literature, board composition—predominantly board independence—is commonly used as a variable that can positively impact disclosure and transparency, quality of risk management and long-term perspectives on value creation, on the basis that independent directors are more concerned about their reputation. This argument is challenged by the fact that in countries where companies are controlled, independent director markets are inefficient, and boards are less effective. We refer the reader to Bebchuk and Hamdani [8] for a critical perspective on the identification challenges for board independence in developing and emerging economies.

A growing stream of governance research focuses on the implications of boards' gender diversity. A review of this literature concludes that improving women's access to boards is often but not always associated with financial performance [9], although evidence that the presence of women on boards improves environmental, social and ethical aspects of firm behaviour is more equivocal [10]. Recent papers focused on emerging economies suggests that the effect of gender diversity in boards is highly contingent upon the power dynamics in the board and the cultural context [11–18]

Ensuring women's full and effective participation at all levels of decision-making in political, economic and public life is a key element of the 2030 Development Agenda, but the predicted significance of such participation on climate change and sustainability is neither articulated nor explored in policy debate. Recently, some empirical studies specifically investigated the effect of boards' gender diversity on sustainability and climate change reporting [11–14,19,20]. These studies used different specifications to measure diversity and are unequivocal about the implications of boards' gender diversity on sustainability and climate change disclosure. We argue that the mixed results may be related to differences between the impact of different categories of female directors. Female directors may be ineffective for a number of reasons. First, they may be sitting in the boards because they are members of the controlling families, not because they are qualified. They may also represent token appointments or be perceived as tokens by others which makes them ineffective. Women may also be marginalized and therefore be less vocal, especially if the boards are dominated by controlling shareholders who ultimately elect the directors.

In this study, we investigate whether the *effective* involvement of women in board governance can partly compensate for weak climate change disclosure regulations and/or weak enforcement in order to provide input on the discussions about board reforms in emerging economies. Specifically, we examine the impact of gender diversity in board committees on climate change-related disclosures, as directors on committees are better positioned to influence board governance. By focusing on the relationship between climate change disclosure and the presence of women in audit and governance committees in an emerging economy, we contribute to the scarce and unequivocal literature with an in-depth look at women on boards.

Our results show that the inclusion of women in boards matters. However, as expected, it is not the mere presence of women in boards, regardless of their typology, nor the diversity, but instead women's active involvement in the governance of the company, proxied by their participation in governance and audit committees, that predicts climate change disclosure. We discuss these results in the light of the governance regularities in Turkey, where boards are largely ineffective and controlled. Our findings lend support to a more holistic approach to climate change disclosure and board reform in emerging economies.

The rest of the paper unfolds as follows: Section 2 reviews the relevant literature on the gender diversity of corporate boards, Section 3 introduces the context, the sample and the estimation methods employed for the analysis, Section 4 presents the results and Section 5 concludes.

2. Background and Literature

2.1. Voluntary Disclosure

Voluntary disclosure is expected to reduce the cost of capital by reducing the asymmetry of information between companies and investors according to the mainstream agency theory withstanding the assumption of efficient markets [21,22]. Voluntary disclosure may also be a source of competitive advantage by sending signals of better performance according to the signalling theory [23]. Climate change disclosure may be a strategic choice and beneficial to better governed companies according to these theories. Nevertheless, voluntary disclosure is considered to be a public good, since it can help better allocate financial resources and, if sufficiently widespread, it can pave the way for uncontested regulatory disclosure. Disclosure also improves internal controls and monitoring by the board. The financial management and accounting literature is rich on the determinants and the outcomes of voluntary disclosure of non-financial information. Voluntary disclosure is also

addressed in the CSR and business ethics literature. The theory of legitimacy [24] and the stakeholder theory [25] are commonly used to explain the voluntary reporting behaviour of companies [26].

Studies on climate change disclosure can be broadly divided into two categories; those focusing on the determinants of disclosure and those focusing on the outcomes of disclosure, with most studies falling into the latter category. The literature that focuses on the determinants spreads to a wide spectrum of themes. For example, Calza et al. [27], in the case of Italy, showed a positive effect of state ownership and a negative effect of ownership concentration on climate change reporting, while studies that have focused on the outcome of disclosure have mostly looked at the effect on financial performance and firm value [28,29]. The focus on firm value may be explained by the effect of institutional investors defining climate change as the most important sustainability risk in terms of financial materiality [30]. Another study [31] presents a review of this rich literature which largely focuses on developed markets. Recently published exceptions include He et al. [32] on China, which found that the greater the external pressure is, the higher the level of carbon information disclosure. This relationship is stronger for state-owned and heavily polluting companies and for companies with more effective boards. We make use of this literature to select our covariates.

2.2. Boards' Gender Diversity and Disclosure

A stream of research seeks to understand how board gender composition affects organizational outcomes, including disclosure. These studies commonly use agency theory [21], which argues that women are better monitors because they are more independent, and resource dependence theory [33], which theorizes that female directors are likely to add diversity to boards' human capital which leads to improved decision making [34,35]. The economic argument for diversity, on the other hand, focuses on discrimination. If low levels of female directors are a result of gender discrimination, female director appointments are likely to be drawn from the higher end of the ability/productivity distribution of potential female directors [10]. Accordingly, a more gender diverse board may be associated with better decision making, more efficient monitoring, as well as the replacement of less able male directors [34].

Another argument borrows from psychology research and emphasizes the differences in values and traits based on the assumption that women on boards are similar to the general population of women and therefore they are more ethical, risk-averse and long-term oriented [35]. A study by Nielsen and Huse [36] suggested that women may be particularly sensitive to—and may exercise influence on—decisions such as environmental politics.

Empirical studies have had mixed results. Overall, they have suggested that board composition has no significant effect on firm performance and even that the effect of board gender diversity on firm performance can be negative [37,38]. A meta-study by [39] confirmed a largely contextual relationship between gender diversity and organizational outcomes in general, but a positive effect of female directors on corporate social performance. The majority of these studies used US data.

Recently, some studies investigated the relationship between female directors and climate change responsiveness and emission reporting. Research by Bravo [40] demonstrated a positive relationship between the percentage of women in audit committees and environmental reporting in Spain. Additionally, Glass et al. [20] examined the differences between companies with female and male CEOs in Fortune 500 companies, which led to the conclusion that female leadership is more effective in the implementation of environmentally friendly strategies. Studies using CDP data include Ben-Amar et al. [41] on Canadian companies and Liao et al. [14] on UK companies. Both studies have shown that a higher proportion of women on the board increases the probability of reporting to the CDP. Studies on emerging economies are less consistent. Elmagrhi et al. [12] reported the association between the percentage of women on the board and environmental disclosure and performance in China. Contrary to other studies, Husted and de Sousa-Filho [42] report a negative effect of female directors on environmental disclosure in Latin American countries.

Recent studies have revealed the importance of board committees on board effectiveness [43,44]. If decisions to appoint women are driven by social or political pressure leading to token representation, the implications of such appointments are likely to be ambiguous, as empirical

evidence suggests. Women, however, are less likely to be appointed to board committees if they are not expected to contribute to the functioning of these committees. In the case of Turkey, Ararat and Yurtoğlu [45] reported that the presence of women in board committees predicts a higher quality of financial reporting. We, therefore, investigate the implications of women's presence both on boards and in committees to differentiate the effect of independent and professionally qualified women in influencing the climate change disclosure.

Our study contributes to the unequivocal research on the impact of board composition and gender on climate change disclosure because of the unique and hand-collected data which allow us to identify the contextual factors that affect this relationship in an emerging economy where most companies are organised in business groups controlled by families. First of all, our data allows us to classify directors not only according to their gender but also by their status and roles in the board, as well as their affiliation with the controlling families. Second, it allows us to interpret our results under the light of gender diversity trends in Turkey's corporate landscape.

2.3. Our Context; Turkey

We chose Turkey for our investigation. Turkey is an ideal setting for our inquiry for a number of reasons. First, there are no regulatory requirements for climate change disclosure or mitigation nor for gender diversity in corporate boards. Climate change disclosure and the appointment of women on boards are self-selected. The Capital Markets Board of Turkey is authorized by the Commercial Code to regulate the governance of the listed companies in Turkey. The Corporate Governance Principles issued by the Board specify both mandatory and recommended provisions relating to the board structure and disclosure. Companies are required to set up an audit and a corporate governance committee and to have a board of at least five directors. Independence became mandatory in 2012 and the percentage of independent directors converged to 30%, based on the requirement for 1/3 of the directors to be independent. The principles recommend that companies set a gender diversity target of no less than 25%, as well as disclose their progress towards the target on a "comply or explain" basis. However, disclosure on compliance is not enforced [46].

Boards are largely statutory in Turkey. A majority of the firms are controlled by families and floatation rates are low, with an average of around 30%. Important decisions are taken out of the boardroom by the controlling shareholders. The role of board composition is ambiguous, with studies reporting an insignificant and even negative effect of independent directors or female directors on firms' financial outcomes [47,48]. This is, however, not the entire story. A closer look at the data reveals that while the percentage of women on boards has increased slowly from 11.2% to 15.9% from 2010 to 2019, this increase is predominantly a result of independent female director appointments [49]. More importantly, as independent female directors enter the board, they are likely to be appointed to board committees. For example, in 2019 there were 144 independent women in 403 BIST companies. In total, 122 of the women were appointed to audit committees and 91 were appointed to corporate governance committees (with a significant overlap), representing 16% and 17% of the committee members respectively. The rate of increase in the appointment of female independent directors to committees is increasing. For example, the percentage of companies with a female audit committee chair was 4.4%, while the percentage of women on committees was 11.5% in 2011. This ratio was 15.3% and 15.9% in 2019. This shows that independent female director appointments are now less likely to be token appointments and that women are more likely to be entrusted to lead the committee work.

The climate change disclosure front is more straight-forward but presents a bleak picture. Turkey remains one of the two countries that have not ratified the Paris Agreement. More importantly, it has the highest rate of greenhouse gas emission increase in the world, with a coal dependent energy sector, and as such has been included amongst the five countries against which climate activists have filed a legal complaint to the UN for violating the Rights of the Child (See <https://childrensvclimatecrisis.org/wp-content/uploads/2019/09/2019.09.23-CRC-communication-Sacchi-et-al-v.-Argentina-et-al.pdf>). Independent scientists have rated Turkey's climate actions as critically insufficient, noting that if all states had the same level of target setting the global warming

would increase to 4 °C (See <https://climateactiontracker.org/countries/turkey/>, Commitments with this rating fall well outside the fair share range and are not at all consistent with holding warming to below 2 °C, let alone with the Paris Agreement's stronger 1.5 °C limit. If all government targets were in this range, warming would exceed 4 °C). This is also a result of Turkey's departure from the path of accession to the EU. The accession negotiations have been effectively frozen by the European Commission in 2018 on the basis that Turkey has been backsliding in the areas of democracy, rule of law and fundamental rights. Consequently, the pressure on harmonizing Turkey's climate change regulations with that of the EU has decreased. In these circumstances, the role of private actors and the corporate boards become even more important.

In the absence of any regulations or incentives, voluntary disclosure of climate change information reflects more effective board governance and responsiveness to stakeholder demands for companies that do disclose. Surprisingly, a majority of Turkey's largest companies disclose climate change information to the CDP voluntarily and the market cap of companies that responds to the CDP's invitation to disclose approaches 50% of the total market cap [46]. Therefore, it is important to understand what drives this unexpected level of disclosure. Turkey is also an important country on its own for this investigation. It is the world's 17th largest economy and one of the two OECD countries that are considered to be still developing.

3. Data and Empirical Strategy

3.1. Sample Selection and Data

The CDP invited the largest listed firms in Turkey to disclose climate change information since 2010. Our study uses the data from the listed firms on BIST 100, the CDP's official sample, from 2010 to 2019. The source of financial data was StockGround and the climate change data was retrieved from the CDP (Carbon Disclosure Project) Turkey database maintained by the Corporate Governance Forum of Turkey (CGFT) and the CDP. The board diversity data came from the CGFT, which collected the data from KAP (Public Disclosure Platform), the companies' annual reports and internet sources. STATA 15.1 was used to analyse the data. The data analysis included descriptive statistics, the correlation matrix and multivariate logistic regression. Following related research such as [50] in order to control for the endogeneity problem, the explanatory and control variables were lagged by one year.

3.2. Variables and Summary Statistics

Table 1 presents the description of the dependent, independent, and control variables, their measures, and the source for data collection.

Table 1. Variable description.

VARIABLES	Description	Source
Dependent variable		
CDPDISCLOSURE	CDP disclosure status (dummy variable that equals one if the firm disclosed climate change information through CDP questionnaire and zero otherwise)	CGFT/CDP
Board gender diversity variables		
BLAUINDEX	The Blau index of heterogeneity, $H = 1 - \sum_{i=1}^n P_i^2$ where n is number of categories (2 for gender diversity) and Pi the proportion of group members (fraction of female and male directors) in each category	CGFT/PDP
ONEWOMAN	Dummy variable that equals 1 if there is at least one woman sitting on the board of directors and zero otherwise	CGFT/PDP
TWOWOMEN	Dummy variable that equals 1 if there are at least two women sitting on the board of directors and zero otherwise	CGFT/PDP

THREEWOMEN	Dummy variable that equals 1 if there are at least three women sitting on the board of directors and zero otherwise	CGFT/PDP
NBWOMENIND	Number of independent female directors on the board	CGFT/PDP
NBWOMENPRO	Number of professional female directors on the board	CGFT/PDP
NBWOMENFAM	Number of female directors who are controlling family members	CGFT/PDP
NBWOMENAUC	Number of female occupied seats in audit committee	CGFT/PDP
NBWOMENCGC	Number of female occupied seats in CG committee	CGFT/PDP
NBWOMENCGCAUC	Number of female occupied seats in either CG or audit committee	CGFT/PDP
<hr/>		
Corporate governance variables		
INDEPENDENCE	Percentage of independent directors on the board	PDP
CEONOTCOB	Dummy variable that equals 1 if the CEO is not the board chairperson and zero otherwise	CGFT
BOARDSIZE	Total number of directors	PDP
<hr/>		
Other control variables		
FIRMSIZE	Logarithm of total assets	StockGround
LEVERAGE	Debt-to-equity ratio	StockGround
FLOATATION	Free floatation (fraction of freely trading shares)	StockGround
PRICETOBOOK	Price-to-book value of equity	StockGround
PROFITABILITY	Return on assets	StockGround
GLOBALCOMPACT	Global compact membership (Dummy variable that equals 1 if the firm is a member of UN Global Compact and zero otherwise)	UN Global Compact
HIGHCARBON	Dummy variable that equals 1 if the firm belongs to a high carbon impact industrial sector. High carbon impact industries include automobiles and components, chemicals, forest products, gas and electrical utilities, oil and gas, mining, pipelines, precious metals, steel, and transportation	CDP Reports
BUSINESSGROUP	Dummy variable that equals one if company is a member of a business group and zero otherwise	CGFT
AGE	Logarithm of (number of years since original listing on BIST + 1)	StockGround

CGFT: Corporate Governance Forum of Turkey; PDP: Public Disclosure Platform; StockGround: Turkish financial database.

3.2.1. Dependent variable (CDP disclosure status)

This study uses a binary variable (0/1) to evaluate the corporate response to the CDP's request regarding climate change. The CDP's disclosure status equals one if the firm has responded to the CDP's request for public disclosure of climate change strategies and GHG emissions and zero otherwise. Previous research [11,14,51–53] relied on a similar approach of capturing carbon disclosure strategies.

3.2.2. Independent variables

This research used four proxies of female representation on the board of directors. We relied on the Blau index of heterogeneity [54] as a proxy of board gender diversity. The Blau index can take values from 0 when there is only one gender represented on the board to 0.5 when there are equal numbers of female and male directors in the boardroom. Further, this index has been used in prior research [26,55,56] which investigates the effect of board diversity on firm performance on CDP disclosure.

We also used three binary variables (one woman, two women, and three women) to test the effect of a 'critical mass' of female directors on the propensity to provide climate change disclosures to the CDP. We employed another group of binary variables (independent, professional and family) to see if women board members influence CDP disclosure differently if they are independent, professional (all directors who are not members of the families) or family members. Lastly, we examined whether the level of women committee membership affects CDP disclosure. We tested

women committee membership by the number of female occupied seats in audit, corporate governance or both committees.

3.2.3. Control variables

We controlled for the effect of several variables that have been noted in the related literature to affect the voluntary environmental disclosure of companies. We controlled for other board attributes such as the percentage of independent directors. Previous studies [41,57,58] have shown that board independence affects voluntary disclosure. Some other research [41,59,60] has shown that the separation of the chief executive officer (CEO) and board chairperson positions has a positive effect on disclosure quality.

Large boards have a diverse range of experience and skills that may enable them to discharge their duties more effectively [61]. This diversity means that different board members may represent different interests, including those regarding environmental and GHG issues. Moreover, Booth and Deli [62] argued that the uncertainty relating to environmental issues generally leads to large board sizes, in order to allow firms' access to the expertise necessary to overcome this uncertainty. In addition, De Villers et al. [63] stated that larger boards have wider connections with important stakeholders, so that as firms they are 'likely to facilitate access to critical financial resources, allowing such boards more financial leeway to pursue environmental initiatives'. Other disclosure studies that found a positive association include those by Cormier et al. [64] for environmental disclosure in general, Akhtaruddin et al. [65] for voluntary disclosure in Malaysia, and Allegrini and Greco [66] for voluntary disclosure by Italian listed companies. Following the related studies, board size was measured by the total number of board members.

We controlled for the financial variables affecting voluntary disclosure practices. Firm size may have a significant impact on the extent of corporate voluntary disclosure. Large companies are expected to have more resources to implement management systems to track their exposure to climate change-related risks and their preparation of high-quality environmental information. Furthermore, they are more likely to receive extensive attention from the media compared to smaller firms [51]. Previous studies have generally confirmed a positive association between firm size and the extent of environmental reporting [67]. Firm size is expected to be positively associated with the likelihood of response to CDP climate change disclosure. Following prior research, firm size was measured as the natural logarithm of total assets.

Leverage was another control variable which was expected to increase the level of voluntary disclosure due to bankruptcy risk; firms with higher debt ratios may choose to increase their voluntary disclosure level to reduce leverage-related agency costs. Research by Brammer and Pavelin [68] argued that higher leverage may reduce the financial resources available to managers to provide environmental disclosures. They documented a negative association between leverage and environmental disclosures in the UK. However, Luo, Tang and Lan [51] did not report a significant relationship between leverage and the decision to respond to CDP questionnaires in the United States. The leverage was measured by the debt to equity ratio.

Another control variable was the free float rate, which is used as an ownership indicator of Bursa Istanbul firms. According to the agency theory, in a diffused ownership environment, firms will disclose more information to reduce agency costs and information asymmetry [69]. Most of the findings of the studies about voluntary disclosure behaviour give support to the agency theory-based hypothesis that the extent of voluntary disclosure is positively correlated with the wider ownership structure.

Another control variable was the price to book ratio that measures growth opportunities. Firms with good growth opportunities are expected to have higher financial needs and to provide extensive discretionary disclosures to attenuate any potential information asymmetry with investors. Stanny and Ely [51] did not report a significant relation between Tobin's Q and the decision to respond to CDP questionnaires by U.S. S&P 500 firms, however.

Profitability, measured by return on assets (ROA), was another control variable, showing mixed evidence on voluntary disclosure. According to Brammer and Pavelin [68], financially healthy firms

should have more resources to devote to environmental disclosures. However, Stanny and Ely [51] did not find any significant association between firm financial performance and environmental disclosure either.

Previous studies [51,68] have suggested that a firm's industry is a key determinant of its voluntary disclosure strategy. Firms from carbon-intensive industries are subject to higher climate change-related risks and therefore they are expected to provide more information about their climate change-related strategies compared to firms from low carbon industries. We followed the CDP (2008) methodology and defined automobile and components, chemicals, forest products, gas and electrical utilities, oil and gas, mining, pipelines, precious metals, steel, and transportation as high carbon impact industrial sectors [41].

The business group in this study was a binary variable taking a value of one if a firm is member of a business group and zero otherwise. Firms that are business group members are expected to disclose their carbon emission information.

Lastly, firm age was another control variable in our study, measured by the logarithm of the number of years a firm has been publicly listed on Bursa Istanbul. Related studies have shown that old firms have more time to establish extensive stakeholder networks such as research centres to help with climate change disclosure [70,71].

3.3. Research Model

In this study we investigated the effect of gender diversity and board attributes on climate change disclosure using the following logistic regression model:

$$\begin{aligned}
 CDPDISCLOSURE_{(i,t)} &= \alpha_0 + \beta_1 Board\ gender\ diversity_{(i,t-1)} + \beta_2 INDEPENDENCE_{(i,t-1)} \\
 &+ \beta_3 CEONOTCOB_{(i,t-1)} + \beta_4 BOARDSIZE_{(i,t-1)} + \beta_5 FIRMSIZE_{(i,t-1)} \\
 &+ \beta_6 LEVERAGE_{(i,t-1)} + \beta_7 FLOATATION_{(i,t-1)} + \beta_8 PRICETOBOOK_{(i,t-1)} \\
 &+ \beta_9 PROFITABILITY_{(i,t-1)} + \beta_{10} GLOBALCOMPACT_{(i,t-1)} \\
 &+ \beta_{11} HIGHCARBON_{(i,t-1)} + \beta_{12} BUSINESSGROUP_{(i,t-1)} + \beta_{13} AGE_{(i,t-1)} + \varepsilon_i
 \end{aligned} \tag{1}$$

$CDPDISCLOSURE_{(i,t)}$ is the climate change disclosure status of the company i in year t . $Board\ gender\ diversity_{(i,t-1)}$ is the gender diversity dimension of company i in year $t - 1$. The gender diversity dimensions are measured by the Blau gender diversity index, the binary variable for number of women on board (at least one, two and three), the type of female directors (independent, professional family member) and the number of women in audit and corporate governance committee. Furthermore, we looked into the presence of women in board committees, namely on audit and corporate governance committees that are mandatory. β is the coefficient term, ε_i is the error term and α_0 is the constant. Following similar studies such as [41,72], all independent and control variables were lagged by one year.

4. Results and Analysis

4.1. Descriptive statistics

Table 2 provides the summary statistics of the study's dependent, independent, and control variables. The initial sample of this study consisted of firms that have been included in the BIST100 index from 2010 to 2019. Out of the 1000 firm year sample, missing data and the final numbers are shown in Table 2. As shown in the table, an average of 28% of the sample firms provided information to the CDP regarding climate change. Also, the sample firms are relatively large, as demonstrated by the average size (log total assets) of 21.61. In addition, 58% of the sample firms belong to high carbon industries.

Table 2. Descriptive statistics.

VARIABLES	N	Mean	Median	SD	Min	Max
Dependent variable CDPDISCLOSURE	978	0.28	0	0.45	0	1
Board gender diversity variables						
BLAUINDEX	749	0.18	0.20	0.16	0	0.5
ONEWOMAN	749	0.60	1	0.49	0	1
TWOWOMEN	749	0.24	0	0.43	0	1
THREEWOMEN	749	0.08	0	0.27	0	1
NBWOMENIND	749	0.18	0	0.43	0	3
NBWOMENPRO	749	0.49	0	0.74	0	3
NBWOMENFAM	749	0.47	0	0.90	0	5
NBWOMENAUC	744	0.12	0	0.35	0	2
NBWOMENCGC	744	0.22	0	0.49	0	2
NBWOMENCGCAUC	744	0.34	0	0.70	0	4
Corporate governance variables						
INDEPENDENCE	741	21.83	28.57	15.25	0	60
CEONOTCOB	744	0.47	0	0.50	0	1
BOARDSIZE	749	8.50	9	2.36	3	18
Other control variables						
FIRMSIZE	770	21.61	21.61	1.50	17.68	26.64
LEVERAGE	767	1.58	1.09	1.87	-2.80	12.98
FLOATATION	869	36.09	32.00	18.86	2	100
PRICETOBOOK	866	2.04	1.39	2.50	-6.45	21.14
PROFITABILITY	770	0.03	0.03	0.08	-0.65	0.96
GLOBALCOMPACT	882	0.17	0	0.37	0	1
HIGHCARBON	1,000	0.58	1	0.49	0	1
BUSINESSGROUP	1,000	0.36	0	0.48	0	1
AGE	756	2.72	2.94	0.73	0	4.72

Table 3 displays the correlation analysis. Female committee membership in both audit and corporate governance committees have a high correlation with voluntary disclosure. The other dimensions of gender diversity do not show a significant correlation with CDP disclosure. There are also positive and significant correlations between the percentage of independent directors on boards and female committee membership and firm size. The relatively low correlation coefficients among our explanatory variables suggest that multicollinearity may not be a serious threat in our multivariate analysis.

4.2. Multivariate analysis

Table 4 presents the results of logistic regression on board gender diversity and the control variables. The proxies of gender diversity in these regressions were binary variables of presence of at least one, two or three female board members and a measure of gender diversity (the BLAU index value). None of the coefficients of a critical mass of one, two or three women nor the Blau Index value show a significant effect on CDP disclosure. The only board attribute that is correlated with CDP disclosure is board independence. We tested the interaction effect of board independence and gender diversity on CDP disclosure. According to the un-tabulated results, the negative effect of the BLAU index becomes positive when there are more independent board members. The change in R-squared is (0.017), which is statistically significant. As expected, firm size, leverage, being a high carbon industry firm, and firm age are significantly correlated to climate change disclosure. Being a member of a business group is also correlated with climate change disclosure and all these variables are correlated. This covariant is not tested in prior literature and can be explained by the reputational concerns of large business groups. Profitability and floatation have no effect and market value has a mildly significant effect.

Table 3. Correlation matrix.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. CDPDISCLOSURE	1																
2. BLAUIINDEX	0.04	1															
3. NBWOMENAU	0.08	0.31***	1														
4. NBWOMENCGC	0.16***	0.41***	0.41***	1													
5. NBWOMENCGCAUC	0.15***	0.44***	0.77***	0.9***	1												
6. INDEPENDENCE	0.20***	0.02	0.15***	0.2***	0.2***	1											
7. CEONOTCOB	0.06	-0.05	0.06	0.00	0.03	0.06	1										
8. BOARDSIZE	0.10*	-0.12**	-0.02	-0.07	-0.05	0.37***	0.4***	1									
9. FIRMSIZE	0.27***	0.05	0.02	0.14***	0.11**	0.39***	0.2***	0.4***	1								
10. LEVERAGE	0.20***	0.00	-0.03	0.04	0.01	0.2***	0.2***	0.2***	0.3***	1							
11. FLOATATION	-0.10*	0.01	0.00	-0.03	-0.02	-0.04	-0.1***	-0.1*	-0.2***	-0.1*	1						
12. PRICETOBOK	-0.03	-0.18***	-0.04	-0.08	-0.07	-0.02	0.03	0.06	-0.1**	0.4***	-0.08*	1					
13. PROFITABILITY	0.00	0.08*	-0.02	0.00	-0.01	-0.05	-0.04	0.01	0.00	-0.2***	-0.07	0.2***	1				
14. GLOBALCOMPACT	0.09*	0.04	0.05	0.01	0.03	0.17***	-0.02	0.1**	0.2***	0.01	-0.18***	-0.1**	-0.01	1			
15. HIGHCARBON	0.14***	0.03	-0.06	-0.02	-0.05	-0.03	0.08	-0.01	-0.09*	0.1***	-0.11**	0.2***	0.2***	-0.05	1		
16. BUSINESSGROUP	0.14***	0.03	0.00	0.04	0.03	-0.04	-0.02	-0.09*	0.02	-0.03	-0.19***	0.07	0.08*	0.06	0.2***	1	
17. AGE	0.15***	0.11**	-0.02	0.07	0.04	0.1*	0.1*	0.2***	0.06	-0.1**	-0.02	-0.2***	0.03	0.1*	0.1***	-0.02	1

* p < 0.05, ** p < 0.01, *** p < 0.001.

Table 4. Logistic regression results: effect of BLAU index and critical mass of female directors on carbon disclosure.

	Model 1		Model 2		Model 3		Model 4	
	CDPDISCLOSURE		CDPDISCLOSURE		CDPDISCLOSURE		CDPDISCLOSURE	
	Coefficient	Z stat	Coefficient	Z stat	Coefficient	Z stat	Coefficient	Z stat
BLAUINDEX	-0.23	(-0.38)						
ONEWOMAN			-0.184	(-0.89)				
TWOWOMEN					0.014	-0.03		
THREEWOMEN							-0.232	(-0.62)
INDEPENDENCE	0.02***	(3.15)	0.023***	-3.19	0.023***	-2.65	0.219***	-2.64
CEONOTCOB	-0.12	(-0.54)	-0.13	(-0.60)	-0.116	(-0.61)	-0.127	(-0.58)
BOARDSIZE	-0.01	(-0.27)	-0.01	(-0.21)	-0.01	(-1.02)	-0.414	(-0.98)
FIRMSIZE	0.31***	(3.80)	0.307***	-3.77	0.309***	-3.76	0.310***	-3.82
LEVERAGE	0.23***	(3.41)	0.231***	-3.48	0.223***	-3.4	0.228***	-3.44
FLOATATION	-0.00	(-0.23)	-0.002	(-0.26)	-0.001	(-0.40)	-0.00218	(-0.35)
PRICETOBOOK	-0.10*	(-1.76)	-0.102*	(-1.87)	-0.091*	(-1.74)	-0.0958*	(-1.79)
PROFITABILITY	0.53	(0.38)	0.611	-0.44	0.482	-0.34	0.52	-0.37
GLOBALCOMPACT	0.02	(0.08)	0.031	-0.12	0.02	-0.04	0.00114	0
HIGHCARBON	0.69***	(2.89)	0.711***	-2.96	0.697***	-2.85	0.648***	-2.64
BUSINESSGROUP	0.68***	(3.28)	0.680***	-3.29	0.674***	-3.25	0.669***	-3.25
AGE	0.47***	(2.98)	0.479***	-3.03	0.463***	-2.91	0.464***	-2.96
Constant	-10.19***	(-5.71)	-10.141***	(-5.67)	-10.225***	(-4.94)	-9.276***	(-4.98)
Observations	621		621		621		621	
Pseudo R-sq	0.141		0.142		0.141		0.137	
log-likelihood	-326.4		-326		-326.4		-327.9	
Prob > chi2	0		0		0		0	

*** p < 0.01, ** p < 0.05, * p < 0.1.

We then looked at the different categories of female directors to understand if women affiliated with dominant families who did not suffer from the glass ceiling effect and women who are professional outsiders have a different effect on disclosure. Table 5 presents the results of logistic regression on the presence of different categories of female directors and the control variables. The proxies of gender diversity in these regressions are binary variables of the presence of independent, professional or controlling family affiliated women on boards. The results do not show any significant effect of these independent variables on CDP disclosure. The presence of independent women has no significant effect when controlled for total independence. It is, however, worth noting that the coefficient for family affiliated women is negative, whereas the coefficient for the presence of professional women is positive. These results should also be interpreted in consideration of the patriarchal culture. Some of the family affiliated female directors sit in the board together with family affiliated male directors. It is likely that female board members affiliated with families are less vocal when their fathers or brothers sit in the board. Both male and female members of the families sit in the boards of roughly 38% of the companies whose boards include family affiliated directors.

Table 5. Logistic regression results: effect of female independent, professional and family board members on CDP disclosure.

	Model 1 CDPDISCLOSURE		Model 2 CDPDISCLOSURE		Model 3 CDPDISCLOSURE	
	Coefficient	Z stat	Coefficient	Z stat	Coefficient	Z stat
NBWOMENIND	-0.03	(-0.12)				
NBWOMENPRO			0.05	(0.38)		
NBWOMENFAM					-0.105	(-0.93)
INDEPENDENCE	0.02***	(3.13)	0.02***	(2.62)	0.216***	(2.60)
CEONOTCOB	-0.11	(-0.52)	-0.11	(-0.60)	-0.123	(-0.56)
BOARDSIZE	-0.01	(-0.21)	-0.01	(-1.02)	-0.421	(-0.99)
FIRMSIZE	0.31***	(3.80)	0.31***	(3.73)	0.305***	(3.79)
LEVERAGE	0.22***	(3.39)	0.22***	(3.42)	0.235***	(3.51)
FLOATATION	-0.00	(-0.23)	-0.00	(-0.39)	-0.00216	(-0.35)
PRICETOBOOK	-0.09*	(-1.73)	-0.09*	(-1.72)	-0.0999*	(-1.86)
PROFITABILITY	0.49	(0.35)	0.46	(0.32)	0.553	(0.40)
GLOBALCOMPACT	0.02	(0.09)	0.02	(0.03)	0.00423	(0.02)
HIGHCARBON	0.69***	(2.89)	0.69***	(2.84)	0.642***	(2.65)
BUSINESSGROUP	0.67***	(3.26)	0.67***	(3.21)	0.658***	(3.19)
AGE	0.46***	(2.93)	0.46***	(2.89)	0.470***	(2.98)
Constant	-10.24***	(-5.73)	-10.18***	(-4.91)	-9.137***	(-4.96)
Observations	621		621		621	
Pseudo R-sq	0.141		0.141		0.138	
log-likelihood	-326.4		-326.4		-327.7	
Prob > chi2	0.000		0.000		0.000	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Having no evidence of an impact of women's presence in boards on climate change disclosure, we turn to the impact of women's presence in the board committees, which we expect to be a better predictor of more effective governance based on the prior board literature cited above. Table 6 presents the results of logistic regression on board committee diversity and control variables. The proxies of gender diversity in committees in these regressions are the number of women in audit committees, corporate governance committees and in both committees. Based on the results, the effects are significant at 10% for the number of women in audit committee and corporate governance, respectively. The effect is more significant at 5% when there are more women in both audit and corporate governance committees. Committees are small teams, with a median of 2 members. In such small teams, the presence of one woman represents a considerably higher gender diversity than the presence of women at 10%–15% in the boards during the study period. Are these women more qualified? We are not able to compare the qualifications of women on committees with the qualifications of other women or men in general, but it is likely that they are professionally qualified since committee membership requires a higher level of skills, especially for the audit committee.

Committees are unlikely to include the chairman of the firm, who in many cases dominates the board deliberations as a member of the dominant families. This may create an environment where women can become more vocal.

Table 6. Logistic regression results: effect of female committee membership on CDP disclosure.

	Model 1		Model 2		Model 3	
	CDFDISCLOSURE		CDFDISCLOSURE		CDFDISCLOSURE	
	Coefficient	Z stat	Coefficient	Z stat	Coefficient	Z stat
NBWOMENAU	0.48*	(1.73)				
NBWOMENCGC			0.36*	(2.10)		
NBWOMENCGCAUC					0.327**	(2.40)
INDEPENDENCE	0.02***	(2.81)	0.02***	(2.20)	0.178**	(2.09)
CEONOTCOB	-0.16	(-0.72)	-0.12	(-0.65)	-0.169	(-0.76)
BOARDSIZE	-0.01	(-0.18)	-0.00	(-0.63)	-0.265	(-0.62)
FIRMSIZE	0.32***	(3.87)	0.30***	(3.60)	0.300***	(3.69)
LEVERAGE	0.23***	(3.46)	0.22***	(3.32)	0.223***	(3.38)
FLOATATION	-0.00	(-0.27)	-0.00	(-0.38)	-0.00247	(-0.40)
PRICETOBOOK	-0.09*	(-1.70)	-0.08	(-1.61)	-0.0850	(-1.63)
PROFITABILITY	0.49	(0.35)	0.39	(0.26)	0.394	(0.29)
GLOBALCOMPACT	0.00	(0.02)	0.04	(0.15)	0.0255	(0.10)
HIGHCARBON	0.73***	(3.02)	0.72***	(2.93)	0.731***	(3.01)
BUSINESSGROUP	0.67***	(3.21)	0.64***	(3.08)	0.637***	(3.07)
AGE	0.48***	(3.02)	0.45***	(2.79)	0.450***	(2.86)
Constant	-10.45***	(-5.82)	-10.06***	(-4.96)	-9.419***	(-5.05)
Observations	621		621		621	
Pseudo R-sq	0.145		0.145		0.144	
log-likelihood	-325		-324.7		-325.2	
Prob > chi2	0.000		0.000		0.000	

*** p < 0.01, ** p < 0.05, * p < 0.1.

Based on the observation of the impact of women in audit committees on climate change disclosure, we wanted to know whether the gender of audit committee membership matters. We then regressed the female audit committee chairmanship on climate change disclosure. The un-tabulated results show that the impact of a female audit committee chair is larger than the impact of women's presence in audit committees. The effect of a female audit committee chair is significant at a 5% level, with coefficient of 1.025 and a z stat of 2.2, which shows a high influence on climate change disclosure. As shown in Table 6, the coefficients of the number of women in audit committees, corporate governance committees and either of those committees are 0.48, 0.36 and 0.33, respectively. The odds ratios of the mentioned variables are 1.62, 1.43 and 1.39, respectively (odds ratio equals to $\exp(\text{coefficient})$ in logistic regression). This means that adding one woman to an audit committee could increase the likelihood of climate change information disclosure by 62%. This number for corporate governance committees is 43%. Moreover, the odds ratio for a female audit committee chair is 2.79, which shows that the chances of disclosure are almost 3 times as high when a woman is appointed as an audit committee chair. Furthermore, in order to test the robustness of the model, we analysed the effect of board independence on climate change disclosure, while using female committee membership and the Blau index of gender diversity as control variables. Similarly to Table 6, the rest of the control variables were still included in this regression equation. The findings were consistent with the results that are presented in Table 6, showing the significant effect of board independence and female committee membership at 5% level.

These results provide reasonable evidence that board diversity reforms that mandate or encourage gender diversity in boards can improve the levels of climate change disclosure; however, not all women are equally effective, as the results indicate. We see no effect of the overall presence of women in boards on climate change disclosure in Turkey when they are all clustered together. On the other hand, although statistically insignificant, the negative coefficient of female board members

who are affiliated with controlling families, constituting approximately half of all female directors, is the largest. The coefficient turns positive when only non-family board members (professional female board members) are included in the regressions. This may indicate that female family members have a lower competence, or they are less interested in transparency and risk management than professional female board members. Further research is needed to test these possible explanations.

A more plausible explanation of the no-effect could be “marginalization”. Over the study period, the average percentage of women on boards was less than one within an average board size of 8.5 for the sample firms. Most companies with female board members had one or two female directors. On the other hand, women in committees would not be marginalized, since the average committee size is three (un-tabulated). Furthermore, directors who are appointed to audit committees, and the majority of the heads of risk management and corporate governance committees must be independent. It is safe to assume that the women in board committees are independent and competent. Since the functioning of committees is important for the board to fulfil their fiduciary duties, the boards are more likely to choose competent members to the committees than token members.

5. Conclusion and Implications for Reforms

This paper investigates the potential impact of board composition on corporate disclosure of climate change-related information. Our inquiry relies on the global CDP initiative, backed up by institutional investors around the world, and the CDP database of corporate climate change disclosures. The study makes use of hand collected data of a sample of the largest Turkish companies over the period 2010–2019. The institutional context of our investigation makes our results relevant for countries with weak environmental regulations, a high gender gap, high ownership concentration and ineffective boards dominated by controlling shareholders. The results suggest that the main driver of climate change disclosure in Turkey for the period between 2010 and 2019 is internal governance exercised by the boards, not the regulations. Overall, the results show that board independence is a significant predictor of climate change disclosure, but the effect of female independent directors is insignificant and inconsistent, thus, the presence of women on boards doesn't have any predictive power on climate change disclosure. We report, however, reasonable evidence for the positive impact of independent female directors on voluntary climate change disclosure. Given the fact that almost half of the women on corporate boards in Turkey are affiliated with the owner families in Turkey, these results confirm that not all female directors are the same. The presence of female directors predicts voluntary disclosure of climate change information when they are professionally qualified and when they are given the opportunity to influence the governance of the firm. This opportunity takes the form of board committee membership in the case of Turkey.

Our results are of interest to regulators and policy makers. Gender diversity in boards has become a criterion for investment analysis and inclusion in indices (See, for example, FTSE All-Share® Women on Boards Leadership Index and Russell 1000® Women on Boards Leadership Index calculated by London Stock Exchange Group. Methodologies developed by rating agencies to use in scoring companies' ESG performance include board gender diversity as a criterion. See Vigeo-EIRIS (<http://vigeo-eiris.com/>) and Sustainalytics (<https://www.sustainalytics.com/>) as examples.) that aim to capture sustainability indicators [37]. Although the argument for the inclusion of women is supported by moral concerns about discrimination, stemming from the incongruence of the percentage of women in the labour force and percentage of women in decision making bodies including boards, studies, including this study, show that a closer look at board dynamics is necessary in formulating board reforms if the purpose goes beyond moral imperatives, which takes into consideration the ownership structures and the cultural norms. Our results support the argument for board reforms that encourage board independence, board gender diversity and nomination processes that can mitigate gender biases.

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