

Breaking the Green Ceiling: Female Leadership and Environmental Compliance in Brazilian Firms

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ABSTRACT

Are women more environmentally friendly than men? Some recent studies suggest they are due to early socialization that encourages care for others. This paper explores this question within the Brazilian context, focusing on the Amazon region and environmental issues. We compiled a comprehensive database of Brazilian companies, using administrative records of firms, workers, and environmental infractions from 2011 to 2015. Utilizing Probit and Poisson models, we estimate the impact of managerial gender diversity on firms' environmental behavior. Robustness checks with sub-samples and placebos corroborate our conclusions. Our results indicate that having women in management positions reduces both the number of environmental infractions and the likelihood of environmental crime notices against Brazilian firms.

RESUMO

As mulheres são mais amigas do ambiente do que os homens? Alguns estudos recentes sugerem que se devem à socialização precoce que incentiva o cuidado com os outros. Este artigo explora essa questão no contexto brasileiro, com foco na região amazônica e nas questões ambientais. Compilamos um banco de dados abrangente de empresas brasileiras, usando registros administrativos de empresas, trabalhadores e infrações ambientais de 2011 a 2015. Utilizando modelos Probit e Poisson, estimamos o impacto da diversidade de gênero gerencial no comportamento ambiental das empresas. Verificações de robustez com subamostras e placebos corroboram nossas conclusões. Nossos resultados indicam que ter mulheres em cargos de gestão reduz tanto o número de infrações ambientais quanto a probabilidade de notificações de crimes ambientais contra empresas brasileiras.

Keywords: Environmental Infractions, Manager's sex diversity, Brazilian companies, Firm's environmental behavior.

JEL Code: J16; K32; Q56.

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1. Introduction

The United Nations Conference on Environment and Development Report stated: "Women have a vital role in environmental management and development. Their full participation is, therefore, essential to achieve sustainable development" (United Nations, 1992). This highlights the importance of gender in sustainable development discussions. Several studies have observed differences in environmental behavior between men and women. Women tend to be more environmentally friendly than men (Hunter et al., 2004; Agarwal, 2009), possibly due to early socialization that encourages care for others, which can influence attitudes toward the environment (Basnett, 2012; Liu, 2018; Fortnam et al., 2019). This makes women essential agents in environmental preservation (Jacobi et al., 2015).

Although the benefits of gender diversity on boards are widely advocated from economic and environmental perspectives, few studies directly link board gender diversity to environmental outcomes (Glass et al., 2016; Alazzani et al., 2017; Yang et al., 2018; Liu, 2018; Nadeem et al., 2020; Wang et al., 2021). Even fewer studies focus on the gender of managers (Ouni et al., 2020; Mungai et al., 2020)

Van der Walt and Ingley (2003) developed a taxonomy describing what diversity means on boards and its implications for decision-making. They noted that progress toward gender-balanced boards has been slow but is crucial. In the labor market, women directors seek specialized advisors (Liu, 2018) and are more likely to invest sustainably (Joecks and Vetter, 2013). According to Nguyen et al. (2020), increasing the proportion of female directors is a critical internal monitoring mechanism restricting managers' opportunistic behavior.

Kanter (1977a) had already reflected on the need for more balanced groups to ensure women's opinions are appreciated, leading to higher quality decisions and more effective company performance (Kanter, 1977b). For this to happen, there must not be a dominant group, meaning the number of women on boards is essential for them to have an active voice in corporate discussions (Agarwal, 2009; Joecks and Vetter, 2013; Liu et al., 2014). Additionally, minority group members often face increased scrutiny regarding their competence (Muller-Kahle and Schiehl, 2013).

Board directors play a crucial role in shaping corporate decisions related to environmental issues. Glass et al. (2016) found that firms with women in leadership positions are more likely to support environmental initiatives. Gender diversity on corporate boards also decreases the number of environmental offenses, indicating a significant role for women in environmental prevention. Liu (2018) discovered that companies with greater gender diversity on their boards perform better and face fewer environmental lawsuits. Elmagrhi et al. (2019) found that the proportion of female directors and their age positively impact environmental performance, although the educational level of women directors does not. Nguyen et al. (2020) reviewed studies on women on boards, noting that only recent research positively impacts financial performance, highlighting the need for continued examination of women directors' effects, including cultural dimensions.

Despite having a low governance quality index (Schiell and Martins, 2016; Martins et al., 2017), Brazil also has low female representation on executive boards. Between 2010 and 2013, 63% of Brazilian companies listed on the stock exchange had no female board members (Silva Júnior and Martins, 2017). Nevertheless, the presence of women on boards is positively correlated with market performance (Black et al., 2009; Lazzaretti et al., 2013; Silva Júnior and Martins, 2017; Costa et al., 2019; Mastella et al., 2021). This finding raises further questions about how gender diversity on boards influences companies' environmental behavior.

Although literature exists on the impact of gender diversity on firm performance, no studies have specifically examined the impact of gender diversity on the environmental behavior of Brazilian firms. Brazil is crucial in the global environment and climate change debate, with one

of the highest biodiversities and the largest rainforest area in the world⁴. In 2010, the Brazilian National Congress discussed a bill requiring 30% female participation on boards of directors of mixed and public economy companies and companies where the union holds the majority of the voting capital⁵. Thus, the Brazilian context provides a unique opportunity to explore the relationship between gender diversity and environmental behavior in companies.

This research aims to estimate the impact of board gender diversity on environmental behavior. We compiled a rich database of Brazilian companies, combining administrative records on companies and workers with environmental violation records from 2011 to 2015. We analyzed infraction records per company and examined the impact of board gender diversity on firms' environmental behavior, controlling for various biases, firm-fixed effects, and other control variables. Robustness checks using sub-samples and placebos were also conducted to validate the results. Our findings have important implications for executives, environmental activists, policymakers, and regulators, supporting insights drawn from gender, socialization, and stakeholder theories.

The paper is divided into five sections. Following this introduction, the literature review covers the relationship between gender and the environment, women's environmental behavior in firm management, and the connection between leadership, gender, and the environment. The third section presents the database, and the fourth section details the methods used. The fifth section discusses the results and robustness analysis, followed by the conclusion.

2. Literature Review

2.1. Sex diversity and Environment

Debates about gender diversity have become increasingly prevalent in both daily life and scientific literature, primarily highlighting the asymmetrical benefits that institutions have historically provided to men (Sent and Van Staveren, 2019). Similarly, environmental issues frequently appear in these debates, as decisions made today will have significant and often irreversible consequences in the future.

In 1992, the United Nations Conference on Environment and Development (UNCED) established principles emphasizing the rights of individuals to lead healthy and productive lives in harmony with environmental protection and economic development. Sustainable development aims to improve ecosystems while maintaining the continuity of natural resources to ensure reasonable environmental quality standards. One principle highlights the crucial role of women in promoting sustainable development⁶.

Evidence shows that behavioral differences exist between genders, influenced by their socialization processes, affecting how society interacts with and evaluates the environment (Calvet-Mir et al., 2016). Women tend to be more committed to environmental sustainability than men, suggesting they are "more friendly" to the environment (Tindall et al., 2003; Zahran et al., 2006; Calvet-Mir et al., 2016). Gender equity is therefore seen as a challenge to creating a sustainable society based on principles of socio-environmental justice (Jacobi et al., 2015). Understanding these gender differences is essential for developing effective and sustainable policies.

Gender Socialization Theory (Gilligan, 1982; Dawson, 1997) posits that socialization processes can predict individual behavior. Cultural norms specific to each gender shape

⁴ For more information: <https://www.gov.br/mre/pt-br/assuntos/desenvolvimento-sustentavel-e-meio-ambiente/desenvolvimento-sustentavel/o-brasil-e-o-meio-ambiente>. Accessed on: August 22, 2023.

⁵ HB nº 7,179/2017: <https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2126313>. Accessed on: March 10, 2021.

⁶ Principle 20: "Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development". See: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf. Accessed on: May 11, 2021.

individuals, with women often guided by common goals and interpersonal relationships, fostering greater care for others (Carlson, 1972; Cumming et al., 2015; Nadeem et al., 2020). Consequently, women may be more concerned with the well-being of all stakeholders, taking measures to prevent environmental risks that could affect entire communities (Liu, 2018).

Agarwal (2009) studied forest councils in India and Nepal to investigate why women are expected to have different environmental behavior standards compared to men. They observed differences in the sex composition of committees, the rules adopted, and the impact on forest protection. Councils with greater female representation had stricter rules and higher levels of forest protection. In areas with more than two women, the probability of forest improvement was fifty-seven percent higher than in areas with fewer than two women.

Fortnam et al. (2019) examined how differences in sex roles and responsibilities affect labor patterns and division, noting that women often have a limited voice in making environmental decisions. They concluded that cultural differences influence women's behavior toward the environment in responsibilities taught from an early age. Ray et al. (2017) found similar results, indicating that sustainability indicators improved in forest communities where women had significant decision-making power. Conversely, Allendorf and Allendorf (2013) reported that while both genders in Myanmar appreciated protected areas, men were seventy percent more likely to have a positive attitude than fifty-eight percent of women.

2.2. Sex, Management of Firms and Environment

Gender/sex equality is a critical development element related to health, education, and jobs and is associated with higher economic growth rates (Braunstein and Seguino, 2018). Furthermore, Braunstein (2019) stated that there is a widespread appeal for increased participation of women in the labor force as a source of growth and development. However, according to Elson and Seth (2019), growth is unlikely to be equally beneficial for men and women unless growth policies seek to improve women's well-being by reducing gender gaps.

There is still little female representation in high-ranking positions within the business environment. In 2014, only thirteen percent of management positions in the world were held by women, according to the MSCI ESG index⁷. Even with recent efforts, women remain underrepresented in corporate leadership roles (Adams, 2016). Women are more reluctant than men to enter competitive environments, and perhaps this helps explain why fewer women become entrepreneurs (Croson and Gneezy, 2009; Rand and Tarp, 2011). However, when women enter this competitive environment, they perform as well as men, and their presence in strategic positions is related to financial success (Croson and Gneezy, 2009; Liu et al., 2014; Reyes-Bastidas, 2018). Higher representation of women on the council is also associated with a better indicator of social and environmental performance (Nadeem et al., 2020).

The behaviors of environmental violations cause irreversible environmental effects and have significant economic effects. For example, disclosure of environmental violations committed by a company causes a significant decrease in the price of its shares (Nogueira and Medeiros, 1999; Xu et al., 2016). Furthermore, a company's poor environmental performance can harm its shareholders, as it can motivate fines and other legal liabilities (Walls et al., 2012).

When assessing the relationship between sex diversity on boards and the environmental responsibilities of firms, the literature finds that those more diversified are more likely to achieve better environmental ratings than other companies. For the reason that women choose less aggressive strategies, investing more in environmental initiatives (Post et al., 2011; Apesteguia et al., 2012).

The importance of female presence in meeting rooms was also noted by Glass et al. (2016),

⁷ MSCI ESG Research is a provider of research-based indexes and metrics to institutional investors worldwide. For more information: <https://www.msci.com/documents/10199/b08aa5c0-5304-4f6c-975f-83a0a6414838>. Accessed on: March 10, 2021.

who studied the effect of the leader's gender on environmental issues, analyzing the percentage of women on the board and the number of interconnections that women on the board have with other boards. The authors suggested four hypotheses with different proportions of each sex in each group, and these groups contain different behaviors with the environment. They found that sex diversity on boards is essential for environmental innovation, avoiding environmental sanctions, and suggesting that companies that wish to optimize their environmental policies should prioritize hiring women for leadership positions.

Also, to understand this relationship between boards with sex diversity and environmental violations committed by companies, Liu (2018) cites the so-called Stakeholder Theory. This theory states that corporate environmental responsibility increases the company's value by properly managing stakeholder relationships and thus eliminating pollution inefficiency. Empirical evidence demonstrates that an environmental policy is positively related to firm value. Liu (2018) investigated whether companies with a greater female representation on the board would have fewer lawsuits for environmental violations in the United States between 2000 and 2015. The results indicated that firms with greater gender diversity on their boards perform best. The presence of female CEOs in companies with low female representation, with two lag periods, reduces by 0.128 the number of disputes per year. Each additional woman on the councils is associated with 0.015 fewer cases per year two periods later.

Resource Dependency Theory discusses the importance of board human capital, focusing on board members' expertise, knowledge, and skills. Human capital on this board is important for the firm's strategies and policies, and, as Schiehl et al. (2018) point out, where these elements complement each other and affect business innovation (Schiehl et al., 2018; Romano et al., 2020). Therefore, the diversity of people within this board is also important from the point of view of human capital, where the literature has also suggested that board diversity is an important mechanism that influences leadership efficiency and the impact on board decisions, including those related to corporate environmental responsibilities (Liao et al., 2015; Elmagrhi et al., 2019).

Dezsö and Ross (2012) reveal that women in senior management positions are associated with better performance in companies in the United States. A given company generates, on average, one percent more economic value with at least one woman on its top management team. The authors suggest that gender diversity can benefit companies, possibly through the different perspectives, skills, and experiences women bring to strategic and operational decisions. Chen and Hassan (2022) also find similar results for China.

In Canada, gender diversity on board and senior management has also been associated with a greater orientation toward ESG. It is suggested that companies with greater gender diversity tend to have a stronger orientation toward ESG issues, which is also linked to better financial performance (Ouni et al., 2020; Romano et al., 2020; Nadeem et al., 2020). Ouni et al. (2020) also highlights that gender diversity appears to have an effect when considered at the highest level of decision making. Therefore, studies have highlighted the importance of gender diversity in leadership as an essential component of sustainable development (Mungai et al., 2020; Romano et al., 2020; Ouni et al., 2020).

Elmagrhi et al. (2019) studied how much gender diversity within the board can affect the environmental performance of 383 listed Chinese companies from 2011 to 2015. The results indicated that the proportion of directors and the age positively affect the company's environmental performance. However, the schooling of women directors has little impact on environmental performance. For the authors, the presence of female directors in highly polluting Chinese companies is extremely low, less than 10% compared to other sectors.

Nguyen et al. (2021) studied the effect of governance structures on the environmental performance of Chinese companies and found that board size and board meetings are positively associated with the environmental performance of Chinese companies. On the other hand, even with positive results, board independence and gender/sex diversity are not associated with

companies' environmental performance.

2.3. Environmental Inspection in Brazil

The Brazilian National Environment Policy (PNMA) designed a system of public environmental policies to ensure sustainable economic development, creating an important system for protecting the environment by public bodies, the National Environment System – SISNAMA (Farias, 2019). Linked to the Ministry of Environment, the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) is the federal environmental agency that implements natural resources' conservation and preservation policy. IBAMA has records of environmental violations that occur throughout Brazil. Many of these violations are typified by the Environmental Crimes Law (Federal Law 9,605/1988), which provides criminal and administrative sanctions for environmental violations (Rodrigues and Lenza, 2018). An environmental infraction is any action or omission that violates the legal rules of use, enjoyment, promotion, protection, and recovery of the environment.

In 2011, a new law allowed municipalities to grant licenses for activities with some environmental impact because each Brazilian municipality has different ecosystem specificities. In the municipal scope, environmental violations are observed with greater precision, and the local authority could act as a supervisor and apply administrative sanctions in the environmental sphere. Therefore, acting more directly, immediately, effectively, and less bureaucratically and at a lower cost to prevent greater transgressions in the environmental sphere (Schmitt and Scardua, 2015; Rodrigues and Lenza, 2018) was possible.

Despite very advanced environmental legislation, Brazil must improve its environmental inspection. It is common to find reports about the difficulty of inspection agents entering territories to carry out their inspection, which can occur for different reasons, such as the lack of people trained to perform this role or the difficulty of reaching the most distant and challenging Brazilian territories⁸. Despite operational difficulties in combating environmental violations, IBAMA has an essential role in inspecting and combating environmental violations.

3. Data

We took advantage of different databases. Information about companies and their directors comes from the base of the Annual Social Information Report (RAIS), an administrative register of the Ministry of Labor, with data on all companies formally registered in Brazil. All companies have a number on the National Register of Legal Entities (CNPJ) with the Federal Revenue Service⁹, which allows the firms to be followed throughout the years. The owner or a management group usually guides private companies.

In contrast, the objectives of public companies can address political issues or other external objectives¹⁰. As Desender et al. (2013) explains, the effectiveness of governance mechanisms must be considered by observing the firm's structure. So, we consider only private firms with more than one employee, excluding public firms because they do not react to market incentives.

We had access to the IBAMA database¹¹, which contains data on environmental violations in Brazil from 2011 to 2015¹². The IBAMA database records whether the firm committed any

⁸ The lack of people trained to carry out inspections also comes because of the physical and psychological threats by illegal agents. In addition, there are also fiscal deficits that have been moved to other diverse areas. According to the NGO Global Witness report, in 2018, Brazil was considered the most dangerous country for environmental advocates.

⁹ The number is composed of 11 digits, of which the first eight numbers form the radical of the CNPJ that performs the identification of the firms, and the last ones show if it is the head office or subsidiary.

¹⁰ This choice was made to exclude from the database those firms registered only with the name of the owner of the same and containing no employees.

¹¹ See: <http://www2.mma.gov.br/port/conama/>. Accessed on: March 10, 2021.

¹² The data that support the findings of this study are openly available in Brazilian Institute for the Environment

environmental violation and, when inspected, had an environmental infraction notice drawn up against it. It is also possible to observe the number of times the same firm was fined during the sample period. We consider two dependent variables. The first is a counting variable, which denotes the number of infraction notices issued against each firm. This variable identifies the additional quantity of environmental infraction notices. The second is a binary variable, with a value of 1 when the firm has some environmental infraction notice and zero for no environmental infraction notice issued against the firm. This dependence makes it possible to identify the probability of an environmental infraction against the firm.

Table 1: Descriptive Statistics

	Average	Standard Deviation	Minimum	Maximum
Infraction Notices (counting var.)	0.022	0.431	0	250
Infraction Notices (binary var.)	0.015	0.120	0	1
Proportion Woman Manager	0.205	0.376	0	1
Proportion Woman Supervisor	0.216	0.329	0	1
Proportion Woman Manager and Supervisor	0.378	0.372	0	1
Firm Characteristics				
Age Women	34.448	5.544	14	82
Age Men	34.580	5.688	14	83
Number of Employees*	0.539	8.555	0.002	1,198.446
Number of Supervisors*	0.019	0.312	0	29.342
Racial Ratio**	0.901	0.299	0	1
Capital	0.471	0.487	0	1
Firms Sectors				
Manufacture	0.210	0.404	0	1
Trade	0.238	0.423	0	1
Services	0.540	0.497	0	1
Agriculture	0.012	0.105	0	1
Lagged Variables				
Proportion Woman Manager $t-1$	0.154	0.336	0	1
Proportion Woman Manager $t-2$	0.107	0.289	0	1
Proportion Woman Manager $t-3$	0.066	0.232	0	1
Firm Sizes				
Up to 4 employees	0.103	0.304	0	1
From 4 to 9 employees	0.123	0.329	0	1
From 10 to 19 employees	0.125	0.331	0	1
From 20 to 49 employees	0.176	0.381	0	1
From 50 to 99 employees	0.116	0.321	0	1
From 100 to 249 employees	0.122	0.327	0	1
From 250 to 499 employees	0.069	0.254	0	1
From 500 to 999 employees	0.052	0.222	0	1
More than 1,000 employees	0.077	0.267	0	1
Schooling of the Woman Manager				
Proportion Woman Manager with Incomplete High School	0.008	0.075	0	1
Proportion Woman Manager with Complete High School	0.083	0.269	0	1
Proportion Woman Manager with Incomplete Undergraduate	0.022	0.143	0	1
Proportion Woman Manager with Complete Undergraduate	0.124	0.306	0	1
Proportion Woman Manager with Graduate	0.009	0.089	0	1

Source: Based on data from IBAMA and RAIS. || Note: Statistics with average values per company.

*Per thousand employees. || **Racial ratio: proportion of white/yellow employees.

To quantify the relationship between the proportion of sex diversity in the management, we created a variable consisting of the number of women present in each company's total number of managers, regardless of sex. We also consider supervisor positions¹³ to perform the robustness analysis that will be explained next. To create these variables, we used the occupation information in the employment relationship present in the RAIS database, which defines the individual's job position in that firm for each declared year.

A group of variables control was included, characterizing the firms in other aspects than women's presence in the firm's management, which is the average number of employees, the average number of supervisors, the average age of employees, a variable of racial proportion, firm's location in the capital or not, in addition to the variables of sectors. In addition, a dummy variable identifies whether the firm is in a state capital or the Federal District. Thus, characterizing the structure of the firms present in the sample enabled an effective analysis of the governance of boards of directors with sex diversity about the environmental behavior of the companies (Desender et al., 2013).

Table 1 presents descriptive statistics for the study variables. Infractions range up to 250 notations, with 0.022 an average, and 1.5% of the firms were assessed for some environmental infractions. Female managers represent 20.5%, on average. In small and micro firms, women managers represent around 22% of directors. Men's and women's average age is around 34 years, which is compatible with the country's demographic structure. Firms' size ranges from 2 to 1,200 thousand employees, and almost 2% are supervisors. White employees are predominant due to the characteristics of the formal labor market in Brazil. State capitals or the Federal District concentrate almost 50% of the firms, reflecting the importance of these cities in the Brazilian economy.

The service sector concentrates about fifty-four percent of the sample. In the sequence, the trade and manufacturing sectors. Agriculture is the small one, with less than 1.3%¹⁴. Small and micro firms (up to ninety-nine employees) represent most of the firms (almost sixty-four percent). However, the presence of higher firms (more than 1,000 employees) is significant in the sample (almost eight percent). Finally, the women managers predominantly have high school or undergraduate schooling.

4. Methodology

4.1. Models

The general equation for the relationship between women on the board and the environmental infraction is given as follows:

$$Y_f = g(MD_f, X_f | \delta) + \varepsilon_f \quad (1)$$

Where Y_f is one of two possible dependent variables: (i) the number of infraction notices by the firms; or (ii) the binary variable identifying whether the firm was noticed or not¹⁵. The variable MD_f shows the proportion of managers in the firm f , and X_f are control variables related to the firm and fixed effects. The vector δ represents the unknown parameters to be

¹³ A supervisor/manager is responsible for supervising and coordinating the activities of a team or department within an organization, being below the board of management in the hierarchical scale of Brazilian companies.

¹⁴ The sectors were separated considering the Brazilian Institute of Geography and Statistics (IBGE) division, which provides the national statistical classifications. To classify the sectors, we used the numbers of National Classification of Economic Activities (CNAE). For more information: <https://cnae.ibge.gov.br>. Accessed: August 21, 2023.

¹⁵ In this study, the type of environmental crime committed is not being considered, much less the magnitude of the fine applied to the environmental infraction notice. Furthermore, we also do not consider the recidivism of companies in environmental crimes of the same nature because, in this study, the scope of research was only the occurrence and frequency of environmental crimes in private companies with sex diversity on the board.

estimated related to the explained variables. Finally, ε_f represents the error term.

The $g(\cdot)$ function could represent a Poisson model, similar to Liu (2018) and Nadeem et al. (2020), when Y_f is the counting variable, a traditional approach for regression models with count data (Wooldridge, 2010)¹⁶ Using the Poisson model, it is possible to observe how the increase in the proportion of women on the board impacts environmental infraction notices. It should be noted that the count data generally exceed the average, causing super dispersion, so it is necessary to include robust standard errors in all regressions Cameron and Trivedi (2005) and Wooldridge (2010).

The $g(\cdot)$ also represents a Probit model when the dependent variable takes on a binary characteristic and estimates the effect of the women on the board on the likelihood of the firm becoming an offender.

4.2. Bias and Endogeneity Control

Unobservable characteristics and sample selection bias can bias the estimation. Selection of the board is not an exogenous process but is endogenously selected by people with the characteristics of the board (Flabbi et al., 2019; Nadeem et al., 2020). Hiring a female manager can be correlated with fewer environmental crimes, for instance. We performed the Heckman procedure (Heckman, 1979) in a first-stage regression considering the probability of hiring a female director and included the Inverse Mills Ratio (IMR)¹⁷ in the main regression. Through this procedure, the possible selection bias of the company self-sampling is corrected in the same way that the recent literature has used (Nadeem et al., 2020).

The second source of endogeneity is those women managers who select themselves to work in companies with a history of attention to environmental issues, a possible reverse causality. Like Liu (2018), this source of endogeneity was controlled using lagged independent variables, such as the proportion of female managers in $t-1$, $t-2$ and $t-3$.

Another source of bias is environmental inspector bias, who may have preferences in the assessment related to the presence of women on the board. Environmental legislation brought the inspector closer to the locations and realities of companies, making the companies subject to the discretionary preferences of a local inspector. We include a variable for each company computing the average proportion of female managers in the micro-region, excluding the company itself, that is:

$$FB_f = \sum_{\substack{i=1 \\ i \neq f}}^{n_r} \frac{Wd_i}{n_r} \quad (2)$$

Where FB_f is the fiscal bias control for the f -th firms, Wd_i is the proportion of women managers of the i -th firm of the r -th micro-region, and n_r is the number of firms in the same area.

We included dummy sector, state, and time variables to control other unobservable characteristics. The sector-fixed controls sector-specific characteristics that determine the management and performance of firms. The state-fixed effects control local effects like legislation, culture, business traditions, and environmental management. Finally, the time-fixed

¹⁶ The fit quality chi-square test is used to determine whether the Poisson model is adequate for the data compared to alternative models, like Binomial negative. The test showed a statistically non-significant result for our data, concluding that the model fits well with the data.

¹⁷ Mills Inverse Ratio: $IMR = \frac{f(x)}{F(x)}$, where $f(x)$ is the probability density function and $F(x)$ is the cumulative density (Heckman, 1979). In the second stage, the IMR acts as a control variable, the firm-specific effects related to the presence of women directors. If the IMR coefficient is significant, the policy effect estimated without it would be biased.

effects control macroeconomic shocks affecting all companies and other time-related effects. Other firm control variables are the number of employees and supervisors, the mean age of male and female employees, race, and the state capital or Federal District¹⁸.

To deal with a possible reverse causality, we use the time lag of the women on the board variables. Reverse causality comes from those women who self-select to work in firms that already behave differently concerning environmental responsibility (Liu, 2018).

4.3. Robustness Analysis

We consider different subsamples of firms' size and educational level as robustness analyses.

Adams (2016) suggests that small companies show a smaller sex diversity on the board, pointing out the need to understand the reasons for the lower female representation on the boards of small companies, and he also noted different performance between large and small companies. Liu (2018) also considers the firm's size in its work, finding that the diversity of the sex of the board is one of the powerful factors in predicting the frequency of environmental lawsuits, but not as much as the size of the firm. So, following the literature findings, we conduct a robustness analysis by considering subsamples of firm size.

We also consider a subsample concerning the schooling of the managers. The literature provides important results for this discussion. Grosvold et al. (2016) found that the education rate of women positively influences the emergence of women as directors. According to Saridakis et al. (2014), such socioeconomic factors have a greater influence on male than female directors in the short term (Nguyen et al., 2020). On the other hand, Elmagrhi et al. (2019), studying the impact of gender/sex diversity on the board, found that the schooling variable of women directors does not impact the firm's environmental performance and does not corroborate predictions that educated directors are more environmentally aware. These results were the same as those found by Gadenne et al. (2019), who stress that a higher educational level is associated with environmental concerns but not environmental behavior.

As another robustness analysis, we also consider the proportion of female supervisors in firms. This variable considers women not in a main decision position, such as manager, but as the team leader in lower positions in the company hierarchy. In addition, we also consider the proportion of women in both positions, manager and supervisor. Such questioning appeared due to studies showing that the presence of other women in the meeting room makes women less reluctant to speak in public. The literature also demonstrates that the greater the number of women, the greater the effectiveness in promoting favorable policies for women since it increases the strength of the vote (Agarwal, 2010). Thus, we tested whether a more significant number of women, through the sum of women supervisors and women managers, affect the company's environmental behavior.

5. Results

5.1. Main Results

Table 2 reports the marginal effects of a set of regressions¹⁹, from the most straightforward strategy to the most complete. The dependent variable is the number of environmental infractions noticed against a firm. The first regression is just a simple regression without any control. In the sequence, we included the covariates and fixed effects controls.

The estimated coefficients for the proportion of female managers are negative and statistically significant, suggesting a reduction in environmental infraction notices with women on the board. There was no significant change in the coefficients when we added the year and

¹⁸ The covariables of the companies, except for the capital variable, were divided by one thousand, allowing a better understanding of the effects.

¹⁹ The marginal effect considered the average value for the continuous variable and zero to dummy.

state fixed effects, which persisted even when the firm covariates were added. The magnitude changed marginally by including sector variables (columns 4 and 8). Considering those results, an increase of one percentage point in the proportion of women managers is associated with a 6.6 percent reduction in environmental infraction notices. The result does not change even when we include controls to the firm or the fiscal preferences for women.

Table 2: Marginal effects of the Poisson method

No. of Environmental Infractions	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Proportion Woman Manager	-0.089*** (0.014)	-0.081*** (0.014)	-0.079*** (0.013)	-0.066*** (0.011)	-0.090*** (0.014)	-0.081*** (0.014)	-0.079*** (0.014)	-0.066*** (0.011)
IMR					0.037* (0.018)	0.050*** (0.016)	0.110 (0.112)	0.091 (0.090)
COVARIABLES								
Firms	No	No	Yes	Yes	No	No	Yes	Yes
FIXED EFFECTS								
Year	No	Yes	Yes	Yes	No	Yes	Yes	Yes
State	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Industry	No	No	No	Yes	No	No	No	Yes
Observations	129,060	129,060	129,060	129,060	129,060	129,060	129,060	129,060

Proportion Woman Managers = total women managers ÷ total managers. || IMR = Inverse Mills Ratio.
Robust standard errors in parentheses. || *** p < 0.01; **p < 0.05; *p < 0.1

Table 3 reports the estimates of the marginal effects of the Probit model, following the same order as in the previous table. The dependent variable indicates environmental infraction notices for a firm. As before, the coefficient of women on the board remains negative and statistically significant at one percent. The presence of women managers reduces by almost 3 percent the firm's likelihood of environmental infraction notice. Once more, the result does not change when we include controls on the firm or the fiscal preferences for women. The Inverse Mills Ratio controls the firm's preferences and, when significant, is positive, suggesting a bias overestimation. The coefficient magnitude changed from -0.041 to -0.037 when IMF was included. Despite this, the change is not relevant considering the confidence interval.

Table 3: Marginal effects for the Probit method

Environmental Infractions (binary var.)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Proportion Woman Manager	-0.041*** (0.001)	-0.037*** (0.001)	-0.036*** (0.001)	-0.030*** (0.001)	-0.041*** (0.001)	-0.037*** (0.001)	-0.035*** (0.001)	-0.029*** (0.001)
IMR					0.010 (0.008)	0.023** (0.008)	0.165*** (0.040)	0.138*** (0.034)
COVARIABLES								
Firms	No	No	Yes	Yes	No	No	Yes	Yes
FIXED EFFECTS								
Year	No	Yes	Yes	Yes	No	Yes	Yes	Yes
State	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Industry	No	No	No	Yes	No	No	No	Yes
Observations	129,060	128,784	128,784	128,784	129,060	128,784	128,784	128,784

Proportion Woman Managers = total women managers ÷ total managers. || IMR = Inverse Mills Ratio.
Robust standard errors in parentheses. || *** p < 0.01; **p < 0.05; *p < 0.1

5.2. Additional Results

Following the literature, we used variables of the proportion of female managers lagging in $t-1$, $t-2$, and $t-3$ to deal with a possible reverse causality, which comes from those women who self-select to work in firms that already behave differentiated concerning environmental responsibility (Liu, 2018). Table 4 presents the estimates for the lags in $t-1$, $t-2$, and $t-3$.

Columns (1) - (4) refer to Poisson counting models, and columns (5) - (8), the Probit models. All strategies consider the whole set of controls used before.

Generally, the results show a negative sign and are statistically significant, except for the lag $t-3$ in the Poisson model. In both sets of models, as the lag increases, the magnitude of the effect decreases. Thus, in this situation, the presence of women on a firm's board of managers is non-positive and probably negative.

5.3. Robustness Analysis

We performed regressions with different types of sub-samples as robustness checks. In Table 5, we consider different sizes of firms according to the number of employees. Marginal effects changed in magnitude and significance levels, but all firm sizes showed a non-positive sign. For the number of infractions, only very small firms (up to 4 employees) presented a non-significant signal, and only 4-9 employee firms presented a significant coefficient at 10%. For all other sizes, the coefficient was significant at 5%. The magnitude of the coefficient is monotonically reduced when the size increases, and, considering the confidence interval, they are similar for large companies (500 employees or more). Considering the potential negative impact of large firms, the presence of women on the boards of these companies has an important impact on the environment.

Table 4: Marginal effects for the lagged female manager ratio

	No. of Environmental Infractions				Environmental Infractions (binary var.)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Poisson	Poisson	Poisson	Poisson	Probit	Probit	Probit	Probit
Proportion Woman Manager in t-1								
PWM $t-1$	-0.034*** (0.005)	-0.036*** (0.006)	-0.034*** (0.006)	-0.026*** (0.005)	-0.019*** (0.001)	-0.019*** (0.001)	-0.018*** (0.001)	-0.014*** (0.001)
IMR	-0.017 (0.013)	0.025 (0.015)	0.391*** (0.110)	0.323*** (0.112)	-0.020** (0.008)	0.008 (0.008)	0.280*** (0.057)	0.238*** (0.048)
Proportion Woman Manager in t-2								
PWM $t-2$	-0.021*** (0.005)	-0.026*** (0.008)	-0.024*** (0.008)	-0.017** (0.008)	-0.012*** (0.001)	-0.013*** (0.001)	-0.011*** (0.001)	-0.008*** (0.001)
IMR	-0.027** (0.012)	0.022 (0.015)	0.448*** (0.114)	0.366*** (0.112)	-0.027*** (0.008)	0.006 (0.008)	0.309*** (0.061)	0.262*** (0.052)
Proportion Woman Manager in t-3								
PWM $t-3$	-0.013*** (0.005)	-0.020** (0.009)	-0.018 (0.009)	-0.011 (0.009)	-0.008*** (0.001)	-0.009*** (0.001)		-0.004*** (0.001)
IMR	-0.031** (0.012)	0.020 (0.014)	0.478*** (0.115)	0.383*** (0.111)	-0.030*** (0.008)	0.005 (0.008)		0.270*** (0.053)
<i>COVARIABLES</i>								
Firms	No	No	Yes	Yes	No	No	Yes	Yes
<i>FIXED EFFECTS</i>								
Year	No	Yes	Yes	Yes	No	Yes	Yes	Yes
State	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Industry	No	No	No	Yes	No	No	No	Yes
Observations	128,784	128,784	128,784	128,784	128,784	128,784	128,784	128,784

Dependent variable: in the Poisson model, number of infraction notices drawn up against company i in year t ; in the probit model, binary variable that assumes 1 if the company i received a tax assessment in year t and 0 otherwise.

PWM (Proportion Woman Manager) = total women managers \div total managers. || IMR = Inverse Mills Ratio.

Robust standard errors in parentheses. || *** p < 0.01; ** p < 0.05; * p < 0.1

Considering the likelihood of infraction, the women on board effect is always negative and significant at 1% for all firm sizes. Even in this situation, the magnitude monotonically decreases as the size increases, confirming the previous results.

We also consider a subsample concerning the schooling of the managers. The educational data levels were rated incomplete high school, complete high school, incomplete undergraduate, complete undergraduate, and graduate. Table 6 shows the results. Each column represents a level of education for women managers, starting with incomplete high school and the last referring to graduate results.

For the Poisson model results, all board instruction degrees are significant at one percent, except incomplete high school, which is significant at 10%. The women on firms' boards reduce the number of environmental infractions when women managers have gone from incomplete high school to completed undergraduate, which is in line with the general results. The effect of greater magnitude appeared for women managers who finished high school, where a 3.3 percent reduction in environmental infraction notices appeared when sex diversity appeared on the board.

Table 5: Marginal effects according to the size of the firm

	Up to 4	4-9	10-19	20-49	50-99	100-249	250-499	500-999	>1,000
No. of Environmental Infractions									
<i>Poisson</i>									
Proportion Woman Manager	-0.017 (0.012)	-0.007* (0.004)	-0.012** (0.005)	-0.025** (0.010)	-0.049** (0.020)	-0.088** (0.034)	-0.107** (0.039)	-0.194** (0.071)	-0.156** (0.060)
IMR	-0.040 (0.057)	-0.018 (0.024)	-0.030 (0.038)	-0.059 (0.076)	-0.117 (0.149)	-0.211 (0.263)	-0.257 (0.317)	-0.466 (0.584)	-0.376 (0.504)
Observations	129,060	129,060	129,060	129,060	129,060	129,060	129,060	129,060	129,060
Environmental Infractions (binary var.)									
<i>Probit</i>									
Proportion Woman Manager	-0.006*** (0.002)	-0.007*** (0.002)	-0.009*** (0.002)	-0.011*** (0.002)	-0.016*** (0.003)	-0.021*** (0.003)	-0.025*** (0.004)	-0.033*** (0.005)	-0.042*** (0.006)
IMR	0.007 (0.011)	0.008 (0.011)	0.010 (0.015)	0.013 (0.020)	0.018 (0.028)	0.024 (0.036)	0.029 (0.043)	0.038 (0.057)	0.049 (0.072)
Observations	128,784	128,784	128,784	128,784	128,784	128,784	128,784	128,784	129,784
COVARIABLES									
Firms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FIXED EFFECTS									
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Dependent variable: in the Poisson model, number of infraction notices drawn up against company i in year t ; in the probit model, binary variable that assumes 1 if the company i received a tax assessment in year t and 0 otherwise.

PWM (Proportion Woman Manager) = total women managers ÷ total managers. || IMR = Inverse Mills Ratio.

Robust standard errors in parentheses. || *** p < 0.01; **p < 0.05; *p < 0.1

According to the Probit model, all levels of education showed significance at one percent and a negative sign, except for female managers with graduate degrees. The effect of greater magnitude and the Poisson model also appeared for those female managers who completed high school, with a 1.5 percent reduction in the firm's likelihood of being fined for violating Brazilian environmental legislation in the presence of sex diversity on the board.

An important observation is that, for both models, graduate women managers have a positive sign instead of a negative. That is, the presence of female managers with graduate degrees increases the number of environmental infractions and the probability that the firm will be fined for environmental infractions. Notably, the proportion of female managers with graduate degrees represents only 3.4 percent of our sample, where most female managers have complete graduate degrees. However, these results demonstrate a different behavior between the different degrees of education and, therefore, insinuate the need for studies focused on ascertaining the relations between the female board's education and the business society's

environmental conduct for the Brazilian reality.

Table 6: Marginal effects on the education of female principals

	(1)	(2)	(3)	(4)	(5)
	Incomplete High School	Complete High School	Incomplete Undergraduate	Complete Undergraduate	Graduated
No. of Environmental Infractions			<i>Poisson</i>		
Proportion Woman Manager	-0.016* (0.009)	-0.033*** (0.007)	-0.013*** (0.005)	-0.016*** (0.004)	0.028*** (0.002)
IMR	0.407*** (0.115)	0.358*** (0.119)	0.394*** (0.112)	0.363*** (0.111)	0.378*** (0.106)
Observations	129,060	129,060	129,060	129,060	129,060
Enviornmental Infractions (binary var.)			<i>Probit</i>		
Proportion Woman Manager	-0.005** (0.003)	-0.015*** (0.001)	-0.006*** (0.001)	-0.007*** (0.001)	0.018*** (0.001)
IMR	0.274*** (0.054)	0.244*** (0.049)	0.270*** (0.053)	0.263*** (0.052)	0.268*** (0.052)
Observations	128,784	128,784	128,784	128,784	128,784
COVARIABLES					
Firms	Yes	Yes	Yes	Yes	Yes
FIXED EFFECTS					
Year	Yes	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes

Dependent variable: in the Poisson model, number of infraction notices drawn up against company i in year t ; in the probit model, binary variable that assumes 1 if the company i received a tax assessment in year t and 0 otherwise.

PWM (Proportion Woman Manager) = total women managers ÷ total managers. || IMR = Inverse Mills Ratio.

Robust standard errors in parentheses. || *** p < 0.01; **p < 0.05; *p < 0.1

An important observation is that, for both models, graduate women managers have a positive sign instead of a negative. That is, the presence of female managers with graduate degrees increases the number of environmental infractions and the probability that the firm will be fined for environmental infractions. Notably, the proportion of female managers with graduate degrees represents only 3.4 percent of our sample, where most female managers have complete graduate degrees. However, these results demonstrate a different behavior between the different degrees of education and, therefore, insinuate the need for studies focused on ascertaining the relations between the female board's education and the business society's environmental conduct for the Brazilian reality.

We also consider women in different leadership positions. Table 7 shows the marginal effects of the proportion of women supervisors and the proportion of women managers and supervisors.

For the Poisson model, the presence of women as supervisors alone is irrelevant to impacting the number of infractions. We achieved a similar result by considering both women managers and supervisors. In this case, the increase in the proportion of female managers or supervisors reduces the number of infractions by 8.2 percent. Such results align with the results found in the literature, which demonstrates that the greater the number of women, the greater the effectiveness in promoting policies favorable to women (Agarwal, 2010).

Considering the likelihood of infractions, both results are negative and significant. The higher proportion of women as supervisors, independent of the women manager, also reduces the probability of infracting the environmental law. The magnitude is higher when considering women as managers or supervisors.

Table 7: Marginal effects for supervisors and management with supervisors

	No. of Environmental Infractions				Environmental Infractions (binary var.)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Poisson	Poisson	Poisson	Poisson	Probit	Probit	Probit	Probit
Supervisors								
Proportion Woman Supervisors	-0.006*** (0.002)	-0.006*** (0.002)	-0.005*** (0.002)	-0.002 (0.002)	-0.001 (0.001)	-0.003*** (0.001)		-0.001* (0.001)
IMR	-0.034*** (0.012)	0.017 (0.014)	0.499*** (0.117)	0.394*** (0.111)	-0.032*** (0.008)	0.004*** (0.008)		0.273*** (0.053)
Managers and Supervisors								
Proportion Woman Manager and Supervisor	-0.119*** (0.018)	-0.108*** (0.018)	-0.105*** (0.018)	-0.082*** (0.013)	-0.054*** (0.002)	-0.049*** (0.002)	-0.046*** (0.002)	-0.038*** (0.001)
IMR	0.015 (0.016)	0.038** (0.017)	0.153 (0.061)	0.168* (0.101)	-0.002 (0.008)	0.016* (0.008)	0.173*** (0.039)	0.160*** (0.036)
<i>COVARIABLES</i>								
Firms	No	No	Yes	Yes	No	No	Yes	Yes
<i>FIXED EFFECTS</i>								
Year	No	Yes	Yes	Yes	No	Yes	Yes	Yes
State	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Industry	No	No	No	Yes	No	No	No	Yes
Observations	129,060	129,060	129,060	129,060	128,784	128,784	128,784	128,784

Dependent variable: in the Poisson model, number of infraction notices drawn up against company i in year t ; in the probit model, binary variable that assumes 1 if the company i received a tax assessment in year t and 0 otherwise.

Proportion Woman Manager and Supervisor = $\sum \text{women managers} + \text{women supervisors} \div \sum \text{managers} + \text{supervisors}$

IMR = Inverse Mills Ratio. || Robust standard errors in parentheses. || *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

A placebo test was carried out to corroborate the results further. A random variable was created and included in the estimates. Table 8 presents the placebo results, and its use determines the results' reliability.

The marginal effects of the placebo test are not significant, highlighting that diversity within management reduces the number of environmental violations committed by companies.

The results of these estimates provide robustness to the main results previously found. In addition, these findings corroborate what is stated in the literature, which suggests that it is necessary to have more than one woman inside the "meeting room" for their opinions to be taken into account (Agarwal, 2009; Liu et al., 2014).

6. Discussion

The literature highlighted the differentiated behavior between gender and sex diversity and the environment. Women are considered "more friendly" to the environment because they show a greater disposition to find strategies for sustainable development. Additionally, women have greater affection for supporting environmental legislation and more attitudes towards the environment, demonstrating higher levels of environmental concern (Zahran et al., 2006; Calvet-Mir et al., 2016).

It is only possible to think about environmental issues by considering Brazil's importance to the environment. Brazil is a country of extreme importance because it has one of the highest biodiversity in the world and has the largest extension of rainforests. So, it is an important country in terms of climate change. According to Organisation for Economic Co-Operation and Development (OECD) (2021), Brazil has developed sound environmental legislation. However, there still needs to be more information on the environmental performance of private companies, indicating the need to improve environmental management in Brazilian companies. Therefore, at the same time that it is an extremely rich country in natural resources and

important to the world because of its environmental richness, it is still scarce about studies that have an intersection between subjects related to the environment, among them gender, environment, and firms.

Table 8: Placebo

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Poisson								
Placebo	0.0014 (0.0071)	0.0011 (0.0071)	0.0012 (0.0071)	0.0013 (0.0069)	0.0014 (0.0071)	0.0011 (0.0071)	0.0013 (0.0071)	0.0014 (0.0069)
IMR					-0.033** (0.012)	0.018 (0.014)	0.532*** (0.117)	0.427*** (0.111)
Observations	129,060	129,060	129,060	129,060	129,060	129,060	129,060	129,060
Probit								
Placebo	-0.0019 (0.0011)	-0.0020 (0.0011)	-0.0021 (0.0011)	-0.0016 (0.0011)	-0.0019 (0.0011)	-0.0020 (0.0011)		-0.0016 (0.0011)
IMR					-0.031** (0.018)	0.004 (0.008)		0.280*** (0.055)
Observations	129,060	128,784	128,784	128,784	129,060	128,784		128,784
<i>COVARIABLES</i>								
Firms	No	No	Yes	Yes	No	No	Yes	Yes
<i>FIXED EFFECTS</i>								
Year	No	Yes	Yes	Yes	No	Yes	Yes	Yes
State	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Industry	No	No	No	Yes	No	No	No	Yes

Dependent variable: counting random variable. || IMR = Inverse Mills Ratio.

Robust standard errors in parentheses. || *** p < 0.01; **p < 0.05; *p < 0.1

This relationship still needs to be specifically discussed in Brazil, even though the Federal Constitution encourages environmental care and sustainable development. This article aimed to test the hypothesis that the presence of women in the composition of Brazilian companies' managers affects the firm's environmental behavior.

To fill this gap, we consider data from companies and environmental infractions from 2011 to 2015, which enabled the creation of two dependent variables: counting the number of environmental infraction notices per company and the binary variable identifying whether the firm has already obtained any environmental infraction notice. The effects were estimated using the Poisson method, which model counts data, and Probit models were used to estimate whether there is any effect on the likelihood of an environmental infraction being issued.

The Poisson method results showed that an increase of one unit in the proportion of female managers in Brazilian firms is associated with a 6.6 percent reduction in the number of environmental infraction notices. In the Probit model, it was observed that the presence of female managers in Brazilian companies reduces by 2.9 percent the likelihood of the company obtaining some environmental infraction notice. Therefore, the results suggest a reduction in the frequency and likelihood of environmental infractions by Brazilian firms with some proportion of female managers.

For a possible problem of reverse causality, concerning those women who self-select to work in companies that already behave differently about environmental responsibility, lagged variables were created for the proportion of women managers in $t-1$, $t-2$, and $t-3$ years. It was noticed that even over the years, female managers continue to cause differences in the environmental behavior of Brazilian firms, thus reducing the likelihood that they will be fined for any violation of Brazilian environmental legislation.

Liu (2018) found that female directors reduce the frequency of environmental processes by 0.012 per year for a temporal lag of three periods. Compared to the results found in this study, the reduction in the probability of being assessed for environmental infractions here in Brazil is 0.004. Even with a result lower than that found in the study referring to the United States, the

results found in the research are robust. They suggest that there is also a diversity of environmental behavior in Brazil with women on the firms' managers.

For a secondary analysis, regressions were estimated with different types of sub-samples. Regarding the firm's size, larger companies have a greater reduction in environmental infractions, up to around nineteen percent, when there is sex diversity in the management. Regarding the schooling of the women managers, the results suggest that principals who have completed high school have the most significant reduction in environmental infractions, of 3.3 percent. Those firms with higher women managers with graduate study degrees on the manager showed increased environmental infractions and the likelihood of an environmental infraction notice being drawn up against the firm.

The proportion of female supervisors and managers plus female supervisors was used as a robustness analysis. This made it possible to estimate whether management affects environmental violations and whether the number of women influences the Brazilian firm's environmental behavior. The effect is subtle for supervisors, but the female manager and supervisor coefficients corroborate the international literature. The greater the number of women in strategic positions, the lower the number of environmental crimes. A placebo test was also carried out to make the results more robust. Its coefficient was insignificant, reinforcing that sex diversity within the manager reduces environmental infraction records.

This study's scope of research was only the occurrence and frequency of environmental crimes in private companies with sex diversity on the board. Therefore, the type and magnitude of environmental crime were not considered, nor were recidivism cases, which is one of this study's limitations.

Our results suggest that in a country with the greatest biodiversity on the planet, women in managerial positions could help with sustainable economic development.

The results show that, following the robust methodology that the previous literature on the subject applied, we managed to fill the gap in the relationship between sex, environment, and firms. Therefore, this study also has some limitations that can serve as a guide for future research aiming to understand these relationships. However, our findings here already have important implications for companies, policymakers, and regulators, as they demonstrate the importance of women in the environmental behavior of Brazilian companies.

REFERENCES

- Adams, R. B. (2016). Women on boards: The superheroes of tomorrow? *The Leadership Quarterly* 27(3), 371–386.
- Agarwal, B. (2009). Gender and forest conservation: The impact of women's participation in community forest governance. *Ecological Economics* 68(11), 2785–2799.
- Agarwal, B. (2010). Gender and Green Governance: *The Political Economy of Women's Presence Within and Beyond Community Forestry*. New York: Oxford University Press Inc.
- Alazzani, A., A. Hassanein, and Y. Aljanadi (2017). Impact of gender diversity on social and environmental performance: evidence from Malaysia. *Corporate Governance: The International Journal of Business in Society* 17(2), 266–283.
- Allendorf, T. D. and K. Allendorf (2013). Gender and attitudes toward protected areas in Myanmar. *Society & Natural Resources* 26(8), 962–976.
- Apesteguia, J., G. Azmat, and N. Iriberry (2012). The impact of gender composition on team performance and decision making: Evidence from the field. *Management Science* 58(1), 78–93.
- Basnett, B. S. (2012). Gender and green governance: The political economy of women's presence in community forestry and beyond by Bina Agarwal; Reviewed by Bimbika Sijapati
- Basnett. *HIMALAYA, the Journal of the Association for Nepal and Himalayan Studies* 31(1), 20.
- Black, B. S., A. G. De Carvalho, and E. Gorga (2009). The corporate governance of privately controlled Brazilian firms. *Revista Brasileira de Finanças* 7, 08–014.
- Braunstein, E. (2019). Gender-inclusive industrialization for growth and development in the context of

globalization. In D. Elson and A. Seth (Eds.), *Gender Equality and Inclusive Growth. Economic Policies to Achieve Sustainable Development*, pp. 76–106. UN Women New York, USA.

Braunstein, E. and S. Seguino (2018). The impact of economic policy and structural change on gender employment inequality in Latin America, 1990–2010. *Review of Keynesian Economics* 6(3), 307–332.

Calvet-Mir, L., H. March, D. Corbacho-Monné, E. Gómez-Baggethun, and V. Reyes-García (2016). Home garden ecosystem services valuation through a gender lens: A case study in the Catalan Pyrenees. *Sustainability* 8(8), 718.

Cameron, A. C. and P. K. Trivedi (2005). *Microeconometrics: Methods and applications*. Cambridge University Press.

Carlson, R. (1972). Understanding women: Implications for personality theory and research. *Journal of Social Issues* 28(2), 17–32.

Chen, C. and A. Hassan (2022, 2). Management gender diversity, executives compensation and firm performance. *International Journal of Accounting and Information Management* 30(1), 115–142.

Costa, L., J. d. O. Sampaio, and E. S. Flores (2019). Diversidade de gênero nos conselhos administrativos e sua relação com desempenho e risco financeiro nas empresas familiares. *Revista de Administração Contemporânea* 23, 721–738.

Crosen, R. and U. Gneezy (2009). Gender differences in preferences. *Journal of Economic Literature* 47(2), 448–74.

Cumming, D., T. Y. Leung, and O. Rui (2015). Gender diversity and securities fraud. *Academy of Management Journal* 58(5), 1572–1593.

Dawson, L. M. (1997). Ethical differences between men and women in the sales profession. *Journal of Business Ethics* 16(11), 1143–1152.

Desender, K. A., R. V. Aguilera, R. Crespi, and M. García-Cestona (2013). When does ownership matter? Board characteristics and behavior. *Strategic Management Journal* 34(7), 823–842.

Dezsö, C. L. and D. G. Ross (2012, 9). Does female representation in top management improve firm performance? A panel data investigation. *Strategic Management Journal* 33(9), 1072–1089.

Elmagrhi, M. H., C. G. Ntim, A. A. Elamer, and Q. Zhang (2019). A study of environmental policies and regulations, governance structures, and environmental performance: The role of female directors. *Business Strategy and the Environment* 28(1), 206–220.

Elson, D. and A. Seth (2019). *Gender Equality and Inclusive Growth: Economic Policies to Achieve Sustainable Development*. New York: UN Women.

Farias, Talden e Machado, P. A. L. (2019). *Licenciamento Ambiental: Aspectos teóricos e práticos – 7ª edição (Environmental Licensing: Theoretical and practical)*. Fórum.

Flabbi, L., M. Macis, A. Moro, and F. Schivardi (2019). Do female executives make a difference? The impact of female leadership on gender gaps and firm performance. *The Economic Journal* 129(622), 2390–2423.

Fortnam, M., K. Brown, T. Chaigneau, B. Crona, T. M. Daw, D. Gonçalves, C. Hicks, M. Revmatas, C. Sandbrook, and B. Schulte-Herbruggen (2019). The gendered nature of ecosystem services. *Ecological economics* 159, 312–325.

Gadenne, D. L., J. Kennedy, and C. McKeiver (2009). An empirical study of environmental awareness and practices in smes. *Journal of Business Ethics* 84, 45–63.

Gilligan, C. (1982). *In a different voice: Psychological theory and women's development*. Harvard University Press.

Glass, C., A. Cook, and A. R. Ingersoll (2016). Do women leaders promote sustainability? Analyzing the effect of corporate governance composition on environmental performance. *Business Strategy and the Environment* 25(7), 495–511.

Grosvold, J., B. Rayton, and S. Brammer (2016). Women on corporate boards: A comparative institutional analysis. *Business & Society* 55(8), 1157–1196.

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica* 47(1), 153–61.

Hunter, L. M., A. Hatch, and A. Johnson (2004). Cross-national gender variation in environmental behaviors. *Social Science Quarterly* 85(3), 677–694.

Jacobi, P. R., V. Empinotti, and R. F. d. Toledo (2015). Gender and environment. *Ambiente & Sociedade* 18(1), 0–0.

Joecks, Jasmin e Pull, K. and K. Vetter (2013). Gender diversity in the boardroom and firm performance: What exactly constitutes a “critical mass?”. *Journal of business ethics* 118(1), 61–72.

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

Kanter, R. M. (1977b). Some effects of proportion on group life: Skews sex ratios and responses to token women. *American Journal of Sociology* 82(5), 965–990.

Lazzaretti, K., C. K. Godoi, S. P. O. Camilo, and R. Marcon (2013). Gender diversity in the boards of directors of Brazilian businesses. *Gender in Management* 28(2), 94–110.

Liao, L., L. Luo, and Q. Tang (2015). Gender diversity, board independence, environmental committee and greenhouse gas disclosure. *The British Accounting Review* 47(4), 409–424.

Liu, C. (2018). Are women greener? Corporate gender diversity and environmental violations. *Journal of Corporate Finance* 52, 118–142.

Liu, Y., Z. Wei, and F. Xie (2014). Do women directors improve firm performance in China? *Journal of Corporate Finance* 28, 169–184.

Martins, H. C., E. Schiehl, and P. R. S. Terra (2017). Country-level governance quality, ownership concentration, and debt maturity: A comparative study of Brazil and Chile. *Corporate Governance: An International Review* 25(4), 236–254.

Mastella, M., D. Vancin, M. Perlin, and G. Kirch (2021). Board gender diversity: performance and risk of Brazilian firms. *Gender in Management: An International Journal* 36(4), 498–518.

Muller-Kahle, M. I. and E. Schiehl (2013). Gaining the ultimate power edge: Women in the dual role of CEO and chair. *The Leadership Quarterly* 24(5), 666–679.

Mungai, E. M., S. W. Ndiritu, and T. Rajwani (2020). Raising the bar? Top management teams, gender diversity, and environmental sustainability. *Africa Journal of Management* 6(4), 269–294.

Nadeem, M., S. Bahadar, A. A. Gull, and U. Iqbal (2020). Are women eco-friendly? Board gender diversity and environmental innovation. *Business Strategy and the Environment* 29(8), 3146–3161.

Nadeem, M., E. Gyapong, and A. Ahmed (2020). Board gender diversity and environmental, social, and economic value creation: Does family ownership matter? *Business Strategy and the Environment* 29(3), 1268–1284.

Nguyen, T. H., M. H. Elmagrhi, C. G. Ntim, and Y. Wu (2021). Environmental performance, sustainability, governance and financial performance: Evidence from heavily polluting industries in China. *Business Strategy and the Environment* 30(5), 2313–2331.

Nguyen, T. H. H., C. G. Ntim, and J. K. Malagila (2020). Women on corporate boards and corporate financial and non-financial performance: A systematic literature review and future research agenda. *International Review of Financial Analysis* 71, 101554.

Nogueira, J. M. and M. A. A. de Medeiros (1999). Quanto vale aquilo que não tem valor? Valor de existência, economia e meio ambiente. *Cadernos de Ciência & Tecnologia* 16(3), 59–83.

Organisation for Economic Co-Operation and Development (OECD) (2021). Evaluating Brazil's progress in implementing Environmental Performance Review recommendations and promoting its alignment with OECD core acquis on the environment. Technical Report: <https://www.oecd.org/environment/country-reviews/Brazils-progress-in-implementing-Environmental-Performance-Review-recommendations-and-alignment-with-OECD-environment-acquis.pdf>. Accessed on September 05, 2023.

Ouni, Z., J. Ben Mansour, and S. Arfaoui (2020). Board/Executive gender diversity and firm financial performance in Canada: The mediating role of environmental, social, and governance (ESG) orientation. *Sustainability* 12(20), 8386.

Post, C., N. Rahman, and E. Rubow (2011). Green governance: Boards of directors' composition and environmental corporate social responsibility. *Business & Society* 50(1), 189–223.

Rand, J. and F. Tarp (2011). Does gender influence the provision of fringe benefits? Evidence from Vietnamese smes. *Feminist Economics* 17(1), 59–87.

Ray, B., P. Mukherjee, and R. N. Bhattacharya (2017). Attitudes and cooperation: does gender matter in community-based forest management? *Environment and Development Economics* 22(5), 594–623.

Reyes-Bastidas, Carolina e Briano-Turrent, G. d. C. (2018). Las mujeres en posiciones de liderazgo y la sustentabilidad empresarial: Evidencia en empresas cotizadas de Colombia y Chile. *Estudios Gerenciales* 34(149), 385–398.

Rodrigues, M. A. and C. P. Lenza (2018). *Direito Ambiental Esquematisado*. Editora Saraiva.

Romano, M., A. Cirillo, C. Favino, and A. Netti (2020, 11). ESG (environmental, social and governance) performance and board gender diversity: The moderating role of CEO duality. *Sustainability* (Switzerland) 12(21), 1–16.

- Saridakis, G., S. Marlow, and D. J. Storey (2014). Do different factors explain male and female self-employment rates? *Journal of Business Venturing* 29(3), 345–362.
- Schiehll, E., K. B. Lewellyn, and M. I. Muller-Kahle (2018). Pilot, pivot and advisory boards: The role of governance configurations in innovation commitment. *Organization Studies* 39(10), 1449–1472.
- Schiehll, E. and H. C. Martins (2016). Cross-national governance research: A systematic review and assessment. *Corporate Governance: An International Review* 24(3), 181–199.
- Schmitt, J. and F. P. Scardua (2015). A descentralização das competências ambientais e a fiscalização do desmatamento na Amazônia. *Revista de Administração Pública* 49(5), 1121–1142.
- Sent, E.-M. and I. Van Staveren (2019). A feminist review of behavioral economic research on gender differences. *Feminist Economics* 25(2), 1–35.
- Silva Júnior, C. P. d. and O. S. Martins (2017). Mulheres no conselho afetam o desempenho financeiro? uma análise da representação feminina nas empresas listadas na BM&FBOVESPA. *Sociedade, Contabilidade e Gestão* 12(1), 62–76.
- Tindall, D. B., S. Davies, and C. Mauboules (2003). Activism and conservation behavior in an environmental movement: The contradictory effects of gender. *Society & Natural Resources* 16(10), 909–932.
- United Nations (1992). Report of the United Nations conference on environment and development. In *Rio de Janeiro (3–14 June 1992) A/CONF.*
- Van der Walt, N. and C. Ingley (2003). Board dynamics and the influence of professional background, gender and ethnic diversity of directors. *Corporate Governance: An International Review* 11(3), 218–234.
- Walls, J. L., P. Berrone, and P. H. Phan (2012). Corporate governance and environmental performance: Is there really a link? *Strategic Management Journal* 33(8), 885–913.
- Wang, Y., C. Wilson, and Y. Li (2021). Gender attitudes and the effect of board gender diversity on corporate environmental responsibility. *Emerging Markets Review* 47, 100-744.
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.
- Xu, X., S. Zeng, H. Zou, and J. J. Shi (2016). The impact of corporate environmental violation on shareholders' wealth: A perspective taken from media coverage. *Business Strategy and the Environment* 25(2), 73–91.
- Yang, Y. E., S. Passarelli, and C. Lovell, Robin J e Ringler (2018). Gendered perspectives of ecosystem services: A systematic review. *Ecosystem Services* 31, 58–67.