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## **Do top management team gender diversity and sustainable compensation policies stimulate corporate water use efficiency? Evidence from Brazil**

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### **Resumo/Abstract**

Drawing on upper echelon and stakeholder theories, this paper investigates the impact of top management team gender diversity and sustainable compensation policy on corporate water use efficiency. Based on a sample of 134 listed firms on the B3 (Brazil Stock Exchange and Over-the-Counter Market) from 2010 to 2021, we applied Feasible Generalized Least Squares (FGLS) method to test the two proposed hypotheses. The results reveal that executive gender diversity does not impact water use efficiency. Furthermore, the findings report that the presence of sustainable compensation policies positively influence corporate water use efficiency. Our findings suggest that companies can include sustainability targets in executive compensation to promote water use efficiency.

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## Do top management team gender diversity and sustainable compensation policies stimulate corporate water use efficiency? Evidence from Brazil

### Abstract

Drawing on upper echelon and stakeholder theories, this paper investigates the impact of top management team gender diversity and sustainable compensation policy on corporate water use efficiency. Based on a sample of 134 listed firms on the B3 (Brazil Stock Exchange and Over-the-Counter Market) from 2010 to 2021, we applied Feasible Generalized Least Squares (FGLS) method to test the two proposed hypotheses. The results reveal that executive gender diversity does not impact water use efficiency. Furthermore, the findings report that the presence of sustainable compensation policies positively influence corporate water use efficiency. Our findings suggest that companies can include sustainability targets in executive compensation to promote water use efficiency.

**Keywords:** Corporate water use efficiency, Executive Gender Diversity, Sustainable Compensation Policy, Brazil, Upper Echelon Theory, Stakeholder Theory

### 1 Introduction

Climate change has been causing weather events such as floods, forest fires, droughts, and shrinking ice fields (Anik et al., 2023). Further, climate change significantly impacts water quality due to pollution (IPCC, 2022; Yuan et al., 2023). As a result, climate change is especially a water crisis (UN Water, 2021). Water use has increased by approximately 1% worldwide over the last 40 years due to population growth, socioeconomic development, and changing consumption patterns (UN Water, 2023). The United Nations estimates that 2.2 billion people lack access to safe drinking water, with only a 4% growth in the number of people who have access between 2016 and 2020 (World Economic Forum, 2023). Accordingly, water scarcity impacts more than 40% of people, which tends to grow with increasing temperatures (UNDP, 2023). Consequently, understanding the determinants of water use is crucial for addressing climate change. In this context, we examine how executive gender diversity and sustainable compensation policy can impact corporate water

The top management team is responsible for strategic decisions (Saeed et al., 2023; Shakil & Abdul Wahab, 2023; W. Zhang et al., 2023), such as water efficiency. It is a primary entity of a corporation (Y. Wu et al., 2023) because of its power to choose the best way to formulate and implement strategic decisions (Burkhardt et al., 2020; Naranjo-Gil & Hartmann, 2007). Cui *et al.* (2019) point out that an excellent top management team leads to greater operational efficiency. Attributes related to the composition of top management teams can influence corporate performance (Saeed, Riaz, et al., 2022b). For example, gender diversity in top echelon positions can influence strategic decisions such as water use efficiency.

Companies are gradually linking environmental, social, and governance targets in executive compensation to meet society's demands for sustainability (Li et al., 2021; Winschel, 2021). For example, since 2008, Intel has linked 3% of employee bonuses to sustainability metrics (Ikram et al., 2019). Accordingly, companies use sustainable compensation policies to motivate managers to undertake carbon initiatives (Adu et al., 2022; Haque & Ntim, 2020). Moreover, these policies are a mechanism that companies adopt to legitimize their activities (Berrone & Gomez-Mejia, 2009), attract the best talent (Phung et al., 2022), and contribute to creating long-term value (Flammer et al., 2019).

Empirical research to date has produced mixed results on the nature of the relationship between executive gender diversity and sustainability performance. Some previous studies



found a positive relationship between top management gender diversity and environmental performance (Aabo & Giorici, 2022; Bose et al., 2022; Burkhardt et al., 2020; Gaio & Gonçalves, 2022; Galletta et al., 2022; Jiang & Akbar, 2018; Kiefner et al., 2022; Mar Alonso-Almeida et al., 2015; Mungai et al., 2020; Pan et al., 2020; Quintana-García et al., 2022; Saeed, Riaz, et al., 2022b; C. Wu et al., 2019; Y. Zhang et al., 2022; Zou et al., 2018), and other studies find a negative (Lu et al., 2020) or neutral (Caby et al., 2022; Tibiletti et al., 2021; Tichenor et al., 2022). Furthermore, the literature presents mixed evidence on whether sustainable compensation policy can improve sustainability performance. For instance, previous studies show positive (Abdelmotaal & Abdel-Kader, 2016; Adu et al., 2022; Baraibar-Diez et al., 2019; Bhuiyan et al., 2021; Cavaco et al., 2020; Flammer et al. 2019; Gull et al., 2022; Haque, 2017; Haque & Ntim, 2020; Kara et al., 2022; Khenissi et al., 2022; Maas, 2018; Sarhan & Al-Najjar, 2022) and inconclusive (Benlemlih et al., 2022; Gebhardt et al., 2022) evidence of sustainable compensation policies and CSR performance. Based on the discussion above, this paper investigates the following research questions: (1) How does top management team gender diversity influence corporate water use efficiency? (2) How does sustainable compensation policies influence corporate water use efficiency? Theoretically, this study is based on the upper echelon and stakeholder theories.

The contributions of this study are three-fold. First, this paper presents new empirical evidence from Brazil, a country characterized by institutional voids (Parente et al., 2013; Ronconi, 2012). These voids occur when the institutions that support the market are inefficient or absent (Khanna & Palepu, 1997, 2010) and are the prime source of increased transaction costs and operational challenges (Khanna & Palepu, 2010). In addition, Brazil has weak minority shareholder protection (Crisóstomo et al., 2020), a strong presence of family firms (Daniel-Vasconcelos et al., 2022), and high ownership concentration (Husted & Sousa-Filho, 2019; Mohieldin et al., 2022). Second, to the best of our knowledge, this is the first study to simultaneously present the influence of executive gender diversity and sustainable remuneration policy on water use efficiency.

Third, previous studies on executive compensation based on sustainability goals have concentrated on countries such as France (Khenissi, Jahmane, et al., 2022), Germany (Baraibar-Diez et al., 2019), the United Kingdom (Abdelmotaal & Abdel-Kader, 2016; Adu et al., 2022; Haque, 2017; Sarhan & Al-Najjar, 2022), and the United States (Flammer et al., 2019; Maas, 2018). Accordingly, this research contributes to the emerging literature on sustainable compensation policies by presenting the Brazilian setting. Although few companies in Brazil have compensation tied to environmental targets, some Brazilian companies are beginning to adopt sustainable compensation policies. For example, Pão de Açúcar Group, Brazil's largest retail and distribution group, has started to adopt carbon emissions reduction targets in executive compensation. Similarly, steelmaker Gerdau has stipulated that as of 2021, about 20% of long-term bonuses will be conditional on environmental targets. In addition, since 2019, Brazil's Telefonica, the country's largest telecom company, has had 20% of executives' variable compensation related to sustainability.

The remainder of this paper is structured as follows. The second section reviews prior literature and proposes research hypotheses. The third section introduces data, variables, method, and measuring model. The fourth section presents the empirical results and discussions. Finally, the five section summarizes the conclusion, theoretical and practical implications, limitations, and future research.



## 2 Theories and hypothesis

The upper echelons theory argues organizational outcomes are influenced by the cognitive bases and values of the powerful actors in the organization (Hambrick & Mason, 1984), i.e., the characteristics of executive management impact corporate outcomes (Hambrick, 2007). Consequently, the upper echelon's features can predict its strategic choices (Hewa Heenipellage et al., 2022). Dhir et al. (2023) point out that the idiosyncrasies of executives affect their decisions. With this, bounded rationality is the main logic in decision-making among executives. Accordingly, top management decisions are not always rational (W. Zhang et al., 2023).

The word "stakeholder" first appeared in 1963 through an internal memo from the Stanford Research Institute (Parmar et al., 2010). Stakeholders are those who affect or can be affected by a company's actions (Freeman, 1984). According to stakeholder theory, executives have obligations to the company's stakeholders (Freeman, 2010), such as the local community, customers, and government (Jones et al., 2017). Thus, the survival of the company depends on the relationship with stakeholders (Bouguerra et al., 2022).

### 2.1 Top management team gender diversity and corporate water use efficiency

According to the upper echelons theory, women can influence CSR through their unique characteristics (Hyun et al., 2022). In this regard, female directors transfer their values and character to companies, pushing them towards better sustainability performance (Saeed, Riaz, et al., 2022b). As a result, female directors can use their knowledge and experience to foster environmental practices (Jiang & Akbar, 2018). Thus, the different attributes between men and women can impact CSR (Aabo & Giorici, 2022).

Female directors have better dialog with stakeholders than male directors (Y. Wu et al., 2023). Gender diversity in top management strengthens relationships with stakeholders (Arslan et al., 2023). It enables stakeholders to have their demands met (Amorelli & García-Sánchez, 2021). Furthermore, executive gender diversity allows a company to negotiate compromise between stakeholders with conflicting interests (Manita et al., 2018).

Previous studies on executive gender diversity and sustainability performance have reported mixed results. For example, Bose et al. (2022), working on a sample of 3,182 unique companies during 2001- 2018, show that female presence in top management positions is positively associated with CSR performance. Using a sample of 351 Chinese companies from 2008 to 2018, Zhang et al. (2022) document a positive association between female CEOs and corporate environmental policies. Mar Alonso-Almeida et al. (2015) report that the female management style has a propensity for a more positive perception of CSR. Based on a sample of 1345 US companies over the period 1991-2009, Quintana-García et al. (2022) conclude that gender diversity at all levels of management is positively associated with superior innovation competence.

Kiefner et al. (2022) find that the presence of female executives will positively influence the adoption of sustainability initiatives for a sample of US companies that are in the Standard & Poor's 500 index. Based on a sample of 496 female executives from 524 listed manufacturing companies in China, Pan et al. (2020) find that female executive inhibit unethical environmental behavior and encourage proactive environmental strategies. Using a sample of 490 companies from China, India, and Pakistan between 2010 and 2017, Saeed et al. (2022) find that the top management team's gender diversity positively influences the adoption of environmental standards. Gaio and Gonçalves (2022) document that the presence of women managers positively influences CSR based on 268 companies in 11 European countries from 2013 to 2019. Using a sample of 86 French firms from 2006 to 2017, Burkhardt *et al.* (2020) suggest



that firms with a higher proportion of women in top management are associated with greater environmental innovation.

Wu et al. (2019) find that female executives positively influence a corporation's philanthropic behavior in a sample of 1944 Chinese companies from 2014 to 2016. Using a sample of 3462 firms from Standard and Poor's Executive Compensation database (ExecuComp), Hyun et al. (2022) report that female participation on the executive team increases CSR ratings. Zou et al. (2018) study the impact of female executives on corporate social responsibility from a sample of 12941 observations from Chinese companies between 2006 and 2014. They conclude that female executives are more likely to encourage CSR reporting. Jiang and Akbar (2018) suggest that female executives increased corporate environmental investment in a sample of 359 Chinese listed companies between 2008-2016. Mungai et al. (2020) examine the association between top management team gender diversity and environmental sustainability in 852 Kenyan companies in 2019. They find that gender diversity in top management teams positively affects the adoption of sustainability initiatives, such as ISO 14001 certification. Based on a sample of 723 non-financial companies from 2014 to 2019, Aabo and Giorici (2022) suggest that female CEOs positively influence ESG performance when the dataset is composed of information from the Bloomberg database. However, they document no significant relationship when the dataset contains information from the Refinitiv database.

However, Tichenor et al. (2022) examine the impact of female leadership on corporate social responsibility practices in 1242 US companies from 2009 to 2015. They conclude that female executives do not influence CSR engagement. Using a sample of 836 companies from 16 developed countries, Caby et al. (2022) find that gender diversity of the top management team does not influence the companies' commitment to climate change management. Using a sample of 200 Italian companies, Tibiletti et al. (2021) suggest that the presence of female CEOs is not significantly associated with CSR disclosure. From a sample of 17,032 observations from Chinese companies between 2011 to 2017, Lu et al. (2020) report that the presence of women on the top management team negatively influences CSR performance in Chinese companies. Despite the mixed results, the presence of female executives is generally beneficial for implementing water use efficiency.

In summary, since upper echelon theory states that the characteristics of CEOs influence corporate decisions and stakeholder theory argues that companies should serve stakeholders' interests, female executives can influence water use efficiency due to their unique characteristics and traits and better communication with stakeholders. Therefore, based on the upper echelon and stakeholder theories, the following hypothesis is proposed:

*Hypothesis 1: Executive gender diversity is positively associated with corporate water use efficiency*

## **2.2 Sustainable compensation policy and corporate water use efficiency**

Given that CSR investments can be inefficient and expensive, some companies may integrate sustainability aspects into executive compensation to reward managers' efforts to invest in non-financial aspects (Z. Wang et al., 2021). Sustainability-oriented compensation signals that sustainability-related activities are on the corporate agenda (Huber & Hirsch, 2017). Accordingly, companies can adopt sustainable compensation policies to signal that they comply with social and environmental regulatory pressures (Aresu et al., 2022). Moreover, firms can



use the sustainability-based compensation policy to encourage managers to implement innovative carbon mitigation projects (Haque, 2017).

Firms also have sustainable compensation policies to meet stakeholder expectations for CSR engagement (Ikram et al., 2019). These policies can help companies expand their social function to meet stakeholder values and communicate their long-term strategies (Qin & Yang, 2022). Since sustainable compensation policies have to meet stakeholder demands, they can manage executive behavior (Baraibar-Diez et al., 2019). When CEOs align their behavior with shareholder demands, they are more interested in establishing CSR initiatives (Velte, 2020). Accordingly, companies can link executive compensation to environmental objectives in response to stakeholder pressure (Radu & Smaili, 2021). For Velte (2022b), sustainability-related executive compensation enables an alignment of interests between management and stakeholders.

The inclusion of sustainability-related targets can stimulate stakeholder loyalty, enhance the company's reputation, and create value for all stakeholders, including shareholders and civil society (Al-Shaer & Zaman, 2019). Flammer et al. (2019) argue that CSR-based compensation can direct executive attention to stakeholders, especially concerning less salient stakeholders such as the environment and local communities. Firms can link manager compensation to sustainability practices to reduce stakeholder conflict (Abdelmotaal & Abdel-Kader, 2016). Further, integrating sustainability aspects into compensation can improve communication with stakeholders (Gebhardt et al., 2022).

Previous studies on adopting sustainability targets in executive compensation and sustainability performance reported mixed results. For instance, Abdelmotaal and Abdel-Kader (2016) highlight a positive relationship between the adoption of sustainability incentives in executive compensation and CSR for a sample of 212 companies in the FTSE 350 firms over the period 2009-2011. Based on a sample of 102 French companies from 2014 to 2019, Khenissi et al. (2022) find that including CSR criteria in compensation contracts improves environmental, social, and governance performance. Using a sample of 330 firm-year observations of firms listed on the Bloomberg European Index 500 over the period 2001-2015, Bhuiyan et al. (2021) report that CEO compensation linked to ESG compliance positively influences environmental investments. Baraibar-Diez et al. (2019) examine the impact of sustainable compensation policy on environmental, social, and governance (ESG) scores in a sample of listed firms from Spain, France, Germany, and the United Kingdom. The results suggest that sustainable compensation policies affect ESG scores, especially when companies have a corporate social responsibility committee.

Using a sample of 379 observations from 494 companies in 13 European countries covering a 15-year period (2002-2016), Haque and Ntim (2020) conclude that sustainable compensation policy positively influences token carbon performance. Kara et al. (2022) find that banks donate more to charities when CEO compensation is linked to CSR targets. Using a sample of 17855 firm-year observations from 30 countries between 2004 and 2015, Tsang *et al.* (2021) report that integrating CSR criteria into executive compensation fosters company innovation. Gull et al. (2022) suggest that sustainable compensation policies positively influence waste management in 8,365 firm-year observations for the period 2002-2017 from 37 countries. Using a sample of 4,533 firm-year observations from companies belonging to the Standard & Poor's 500 Index (S&P 500) between 2004 and 2013, Flammer et al. (2019) document that integrating CSR criteria into executive compensation positively influences green innovation.

Sarhan and Al-Najjar (2022) report that CSR-related compensation positively influences the CSR performance of non-financial companies listed in the FTSE350 index from



2002 to 2016. Using a sample of 400 S&P 500 listed firms for the years 2008-2012, Maas (2018) find that using corporate social performance targets in executive compensation does not influence corporate social performance. From a sample of 262 UK-listed companies from 2009 to 2018, Adu *et al.* (2022) document that sustainability-based compensation improves greenhouse gas emissions reduction performance. Cavaco *et al.* (2020) suggest that compensation tied to environmental targets in stakeholder-oriented companies positively influences sustainability performance. Based on a sample of 256 UK non-financial companies from 2002 to 2014, Haque (2017) concludes that compensation linked to ESG targets positively influences carbon reduction initiatives.

However, Benlemlih *et al.* (2022) conclude that ESG-linked compensation does not influence greenhouse gas emissions. Gebhardt *et al.* (2022) find that sustainable compensation policies do not impact ESG performance. Based on stakeholder theory, we argue that sustainable remuneration policy positively influences adoption of sustainable practices, such as water use efficiency. Hence, the following hypothesis is proposed:

*Hypothesis 2: Sustainable compensation policy is positively associated with corporate water use efficiency*

### 3 Methodology

#### 3.1 Data sources and sample selection

Following previous research (Abreu *et al.*, 2023; Almaqtari *et al.*, 2023; Daniel-Vasconcelos *et al.*, 2022; Xie *et al.*, 2023), we obtain CSR and financial data from *basa Refinitiv Eikon* (formerly Thomson Reuters). It measures a company's ESG performance, commitment, and effectiveness objectively and transparently across ten main themes, such as environmental innovation, human rights, and shareholders (Refinitiv, 2023a). Refinitiv Eikon database has over 700 analysts with local language expertise trained to collect ESG data, operating in different locations worldwide (Refinitiv, 2022). This database covers more than 88% of the local market value with a history going back to 2002 (Refinitiv, 2023a). As such, Refinitiv Eikon is a globally trusted database (Almaqtari *et al.*, 2023).

We start with 6588 records from 579 unique firms listed on B3 (Brazil Stock Exchange and Over-the-Counter Market) over a 12-year period from 2010 to 2021. We removed all firms with missing ESG data, eliminating 5562 firm-year observations. Further, we excluded 25 reports from firms with missing financial data. Thus, the final sample comprises 1001 firm-year observations from 134 Brazilian firms from 2010-2021. Table 1, Panel A presents the sample selection process. Table 1, Panel B provides the distribution of firms across sectors and Table 1, Panel C shows the distribution of the sample by year.

**Table 1**

Sample selection and sample distribution by sector and year

Panel A: Sample selection		
Filtering process	Number of firms	Number of observations
Brazilian firms' observations in the period 2010 – 2021	579	6588
Less observations with missing values of ESG data	437	5562
Less observations with missing values of other financial data	8	25
Final sample	134	1001
Panel B: Distribution by sector		
Sector	N	%
Communication Services	37	3.70
Consumer Discretionary	172	17.18



Consumer Staples	115	11.49
Energy	52	5.19
Financials	127	12.69
Health Care	55	5.49
Industrials	116	11.59
Information Technology	14	1.40
Materials	121	12.09
Real State	29	2.90
Utilities	163	16.28
Total	1001	100
<b>Panel B: Distribution by Year</b>		
<b>Year</b>	<b>N</b>	<b>%</b>
2010	60	5.99
2011	65	6.49
2012	68	6.79
2013	74	7.39
2014	76	7.59
2015	77	7.69
2016	76	7.59
2017	83	8.29
2018	88	8.79
2019	111	11.09
2020	119	11.89
2021	104	10.39
Total	1001	100

Table 1, Panel B shows the sample distribution based on the Global Industry Classification Sector (GICS) retrieved from the Refinitiv Eikon database. GICS is a global classification standard used by asset managers, brokers, stock exchanges, consultants, and research teams (Refinitiv, 2023b). It covers 11 sectors, 24 industry groups, and 69 industries (Refinitiv, 2023b). Table 1, Panel B reports that the consumer discretionary sector is the most represented, with 17.18%, followed by utilities (16.28%), financials (12.69%), and materials (12.09). The least represented sector is information technology, with only 1.40%. Table 1, Panel C, displays the sample distribution by year. It is worth noting that the number of observations gradually increases each year.

### 3.2 Dependent variable

The dependent variable is the corporate water use efficiency from the Refinitiv Eikon database. It is the sum of three dummy variables representing water use efficiency initiatives. These are policy water efficiency, target water efficiency, and water technologies. Policy water efficiency measures whether the company has a system or a set of formal documented processes for efficient use of water and driving continuous improvement. Target water efficiency refers to targets or objectives to be achieved for water efficiency. Water technologies measures whether the company develop products or technologies that are used for water treatment, purification or that improve water use efficiency.

### 3.3 Independent and control variables

The independent variables are top management team gender diversity and sustainable compensation policy. Top management team gender diversity refers to the percentage of female executive members (Bouslah et al., 2023; He & Chittoor, 2022; Tampakoudis et al., 2022). Sustainable compensation policy is a dummy variable that takes value 1 if the company has an



ESG compensation policy and zero otherwise (Gull, Atif, et al., 2023; Gull, Sarang, et al., 2023; Keddie & Magnan, 2023). See the description of the variables in Table 2.

**Table 2**  
Variables description

Variable name	Variable name	Model name	Proxy
Dependent	Corporate water disclosure	WATER	Sum of three dummy variables representing the initiatives related to water use efficiency (policy water efficiency, target water efficiency, and water technologies). Policy water efficiency measures whether the company has a system or a set of formal documented processes for efficient use of water and driving continuous improvement. Target water efficiency refers to targets or objectives to be achieved for water efficiency. Water technologies measures whether the company develop products or technologies that are used for water treatment, purification or that improve water use efficiency.
Independent	Executive gender diversity	EGD	Percentage of female executive members
Independent	Sustainable compensation policy	SCP	Dummy variable that takes value one if the company is audited by a big four and 0 otherwise
Control	Board size	BSIZE	The total number of board members
Control	CEO duality	CEODUAL	Dummy variable that takes the value one if the CEO is also chairman of the board.
Control	Profitability	ROA	Income after taxes for the fiscal period/Total assets
Control	Leverage	LEV	Total debt/Total assets
Control	Firm size	FSIZE	Natural logarithm of total assets

We control for the influence of variables that can affect investment in water use efficiency. We include corporate governance characteristics such as board size and CEO duality. We then add a set of firm-level attributes to explain the determinants of efficient water use. Board size is the total number of board members. Larger boards can improve the managers' monitoring (Wijayanti & Setiawan, 2023). They are more likely to provide resources critical to the firm's survival (Mehmood et al., 2023). Almaqtari et al. (2023) point out that these boards have a higher propensity to link environmental issues to the board agenda. Hence, we argue that board size positively influences water use efficiency. CEO duality is a dummy variable that takes the value one if the CEO is also chairman. CEOs who have the duties of chairman can manipulate information for opportunistic reasons (Giannarakis et al., 2023). They reduce the supervisory role of the board (Sun et al., 2022). Thus, we suggest that CEO duality is detrimental for reducing water use.

At the firm level, we included profitability, leverage, and firm size. Profitability is the ratio between income after taxes for the fiscal period and total assets. Hasan and Jiang (2023) argue that profitable firms are positively associated with CSR. These firms seek to increase their reputation by creating better CSR performance (D. Zhang, 2023). Moreover, profitable firms have enough resources to invest in sustainability (W.-T. Lin et al., 2023). Therefore, we argue that profitable firms invest in activities that reduce water use. Leverage is the ratio between total debt and total assets. Leveraged firms are more likely to invest in activities that give financial returns at the expense of CSR (Hamed et al., 2022). Saeed et al. (2022) point out that leveraged firms are less likely to invest in sustainability initiatives. Hence, we suggest that



leveraged firms have more difficulty implementing water use reduction initiatives. Firm size is the natural logarithm of total assets. Since larger firms have economies of scale that better reflect stakeholder demands, they invest more in ESG activities (Bissoondoyal-Bheenick et al., 2023). They have more media coverage (Borghesi et al. 2014). Kong et al. (2023) point out that larger firms do more CSR activities. Thus, we argue that there is a positive relationship between firm size and water use efficiency.

### 3.4 Empirical models

This study investigates the impact of top management team gender diversity and sustainable compensation policies on corporate water use efficiency. Initially, we perform the Breusch-Pagan test for heteroscedasticity, Wooldridge autocorrelation test and Pesaran test for cross-sectional dependence. The results of the Breusch-Pagan test indicate the presence of heteroscedasticity (prob > chi2 = 0.000). The results of the Wooldridge test reveal the presence of autocorrelation (prob > chi2 = 0.000). The results of the Pesaran test (p=000) suggest the presence of cross-sectional dependence. Thus, we used the Feasible Generalized Least Squares (FGLS) method.

Since the FGLS estimator corrects for heteroscedasticity and autocorrelation problems, it is a frequently chosen method (Reed & Ye, 2011; Xu et al., 2022). Moreover, it is a more efficient estimator than the OLS estimator because it eliminates possible unit roots with the first differencing (Wooldridge, 2015). Thus, the empirical model is shown as follows:

$$\text{WATER}_{i,t} = \beta_0 + \beta_1 \text{EGD}_{i,t} + \beta_2 \text{SCP}_{i,t} + \beta_3 \text{BSIZE}_{i,t} + \beta_4 \text{CEOD}_{i,t} + \beta_5 \text{ROA}_{i,t} + \beta_6 \text{LEV}_{i,t} + \beta_7 \text{FSIZE}_{i,t} + \varepsilon_{i,t} \quad (1)$$

where, WATER is the corporate water use efficiency. EGD is the executive gender diversity. SCP is the sustainable compensation policy. BSIZE is the board size. CEODUAL is the duality between the CEO and chairman. ROA is the profitability. LEV is the leverage. FSIZE is the firm size.

## 4 Results

### 4.1 Descriptive statistics

Table 3 displays the results for the descriptive statistics. The average value of efficient water use initiatives is 0.960 in Brazil, with a standard deviation of 0.693. It is ranges from 0 to 3.

**Table 3**

*Summary statistics*

Variables	Mean	SD	Minimum	Maximum
WATER	0.960	0.693	0	3
EGD	0.077	0.094	0	0.5
SCP	0.199	0.442	0	1
BSIZE	9.833	3.751	1	28
CEODUAL	0.317	0.465	0	1
ROA	0.169	0.239	-0.120	3.164
LEV	0.330	0.188	0	1.573
FSIZE	22.540	1.499	18.569	26.933

Note: This table presents the summary statistics. The sample consists of 134 Brazilian firms from 2010-2021. WATER is the corporate water use efficiency. EGD is the executive gender diversity. SCP is the sustainable compensation policy. BSIZE is the board size. CEODUAL is the duality between the CEO and chairman. ROA is the profitability. LEV is the leverage. FSIZE is the firm size.



Executive gender diversity has an average of 0.077, which indicates the low female representation on Brazilian companies. This diversity ranges from 0 to 0.5. On average, 19.9% of firms have sustainable compensation policies.

#### 4.2 Correlation analysis

Table 4 presents correlation matrix. Corporate water efficiency is positively related to sustainable compensation policy, leverage and firm size. On the other hand, profitability is negatively associated with water disclosure. Furthermore, the variance inflation factor (VIF) statistics report that the VIF values are less than 10, which indicates no serious multicollinearity problem in the data (Wooldridge, 2002).

**Table 4**  
Pearson pairwise correlation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WATER	1.00							
EGD	0.01	1.00						
SCP	0.28*	0.12*	1.00					
BSIZE	0.18*	-0.01	0.16*	1.00				
CEODUAL	0.01	-0.06	-0.06*	-0.18*	1.00			
ROA	-0.12*	-0.04	-0.01*	-0.06*	0.10*	1.00		
LEV	0.10*	-0.07*	-0.03	0.07*	-0.01	-0.01	1.00	
FSIZE	0.35*	-0.10*	0.43*	0.37*	0.01	-0.22*	-0.22*	1.00

Note: This table presents a correlation matrix among dependent, independent and control variables. The sample consists of 134 Brazilian firms from 2010-2021. WATER is the corporate water use efficiency. EGD is the executive gender diversity. SCP is the sustainable compensation policy. BSIZE is the board size. CEODUAL is the duality between the CEO and chairman. ROA is the profitability. LEV is the leverage. FSIZE is the firm size. \* denotes significance of 0.05.

#### 4.3 Multivariate analysis

Table 5 presents the impact of executive gender diversity on water efficiency. The results reveal that the presence of female executive directors has no significant impact on water efficiency ( $\beta = 0.001$ ,  $\rho = 0.706$ ), consistent with the results of previous studies (Caby et al., 2022; Tibiletti et al., 2021; Tichenor et al., 2022). Thus, hypothesis 1 is not supported. This result contradicts the upper echelon theory since the characteristics of female CEOs, such as unique resources and innate values, should encourage the adoption of water use efficiency practices. The evidence also contradicts stakeholder theory that suggests that women have a better relationship with stakeholders by understanding their needs, which allows female executives to consider the interests of all stakeholders.

**Table 5**  
Results on the effects of executive gender diversity on corporate water use efficiency

Dependent variable: Water efficiency			
Feasible Generalized Least Squares estimation			
	Model 1		
	Coefficient	Standard error	p-value
EGD	0.001	0.016	0.706
SCP	0.049	0.009	0.000***
BSIZE	-0.001	0.001	0.828
CEODUAL	0.001	0.002	0.956
ROA	0.009	0.023	0.672
LEV	0.041	0.013	0.002***
FSIZE	0.026	0.003	0.000***
Constant	-0.298	0.092	0.001***



Observations	1001
Firms	134
Wald chi2	76.45***
Period	12

Note: The table shows the results of the Feasible Generalized Least Squares models for the sample consisting of 134 Brazilian firms over the period 2010–2021. WATER is the corporate water use efficiency. EGD is the executive gender diversity. SCP is the sustainable compensation policy. BSIZE is the board size. CEODUAL is the duality between the CEO and chairman. ROA is the profitability. LEV is the leverage. FSIZE is the firm size. \* denotes significance of 0.05. \*\*\*, \*\*, \* indicate significance at the level of 1%, 5%, and 10%.

The impact of the sustainable compensation policy on water use efficiency is positive and significant at the 5% level ( $\beta = 0.049$ ,  $\rho = 0.000$ ). These findings support hypothesis 2, indicating that sustainable compensation policy positively influences water use efficiency. The findings are consistent with stakeholder theory. Increasingly, firms consider the stakeholders' interests when making decisions (Maas, 2018). Firms with sustainability-related executive compensation tend to be responsive to stakeholder concerns (Velte, 2022a), and these firms enhance corporate governance by addressing stakeholder interests (Qin & Yang, 2022). Since executive compensation linked to CSR provides managers with incentives for long-term planning, it benefits shareholders and stakeholders (Z. Li et al., 2019). Accordingly, the inclusion of sustainable compensation policies demonstrates executives' commitment to stakeholder demands for long-term sustainability goals, such as lower levels of waste generation (Gull, Atif, Ahsan, et al., 2022). Thus, a sustainable compensation policy ensures the inclusion of stakeholder objectives in executive compensation (Velte, 2022b).

## 5 Conclusions

Based on a sample of 134 Brazilian firms listed on B3 (Bolsa de Valores e Mercado de Balcão) in the period from 2010 to 2021, this study investigates the impact of executive gender diversity and sustainable compensation policy on water efficiency. We use the FGLS method to test the hypotheses of the study due to the presence of autocorrelation, heteroscedasticity and serial correlation.

The results suggest that top management team gender diversity does not impact water efficiency. The results also indicate the presence of sustainable compensation policy positively affects the adoption of initiatives to increase water use efficiency.

This study provides several timely theoretical and practical implications. This research enriches the perspective of theoretical analysis of the impact of compensation linked to CSR targets on water efficiency. Further, this research offers empirical evidence to support the stakeholder theory. Since sustainable compensation policies consider the interests of all stakeholders, they respond to the demands for water efficiency from the firm's stakeholders. Thus, firms with compensation tied to CSR targets are more likely to reflect their stakeholders' environmental concerns, which helps them gain stakeholder support.

Regarding the practical implications. Our findings report that policymakers interested in sustainability should promote sustainable compensation policies to encourage corporate water use efficiency. In this regard, policymakers should actively promote sustainable compensation policies in Brazilian firms by introducing initiatives that support the inclusion of sustainability targets in executive compensation. For managers, we caution them to pay attention to adopting sustainability criteria in executive compensation because firms with these criteria may be in a better position to encourage water use efficiency practices. Finally, regulators should reinforce sustainable compensation policies by developing regulations that enable the implementation of sustainability incentives more efficiently.



Notwithstanding the contributions of this paper, several limitations remain, which can serve as the impetus for future research. First, we focus on corporate water use efficiency in Brazil. Thus, these findings cannot be generalized in the context of different institutional norms. Second, this research emphasizes quantitative aspects of water efficiency without addressing qualitative issues. Future studies could consider qualitative methods, such as surveys or semi-structured interviews. Third, the current study focused only on companies listed on the Brazil Stock Exchange and Over-the-Counter Market, and as such, we cannot extrapolate the results to the entire population. Future research could analyze non-listed companies.

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