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Does climate governance affect waste disclosure? Evidence from the U.S.

Abstract

Traditional corporate governance mechanisms can improve corporate financial and non-financial disclosures. However, how corporate climate governance affects firms' waste disclosure remains unclear. Contributing to the emerging climate governance concept, this study investigates climate governance's impact on waste disclosure using a sample of U.S. non-financial firms from 2002 to 2019. This study makes two contributions to the disclosure and governance literature. First, it shows that high-quality climate governance improves firms' waste disclosure (including hazardous and non-hazardous waste disclosures). It reveals that climate governance quality affects firms' waste disclosure through several channels. Second, we show that higher waste disclosure and climate governance quality reduce firms' market performance. Climate governance quality has a significant positive moderating role in the relationship between waste disclosure and firms' market performance; higher climate governance quality positively impacts firms' market performance through waste disclosure. The results are robust to alternative proxies for waste disclosure, different regression techniques, and endogeneity issues.

1. Introduction

An important issue discussed at the 26th Conference of the Parties[2] is attaining global net-zero by 2050 through renewable investments, as waste generation rates are rising globally. A recent World Bank report shows that the world generated 2.01 billion tons of solid waste in 2016, and global annual waste generation is expected to increase by 70% by 2050 (*The World Bank*, 2019). Environmental or waste disclosure is becoming a more prominent part of firms' annual reports, indicating that firms strive to improve their non-financial reporting to meet public demands (da ROSA et al., 2015). Therefore, recent accounting and finance research is becoming increasingly interested in environmental (Sharma, Panday, and Dangwal 2020; Simpson, Aboagye-Otchere, and Ahadzie 2022) and waste disclosure in response to societal demands regarding the environmental impacts of business activities (Benjamin et al. 2020; Huang and Chen 2015).

Since stakeholder theory was introduced (Berle and Means 1932; Freeman 1984), several studies have investigated the impact of corporate social responsibility (CSR) and environmental, social, and governance (ESG) disclosure on firm performance and stock returns (Ahsan and Qureshi 2021; Ahsan, Al-Gamrh, and Mirza 2022; Alkaraan et al. 2022; Berk and van Binsbergen 2021; Bui, Houqe, and Zaman 2020; Cahan et al. 2016; Cormier and Magnan 1999; Du and Yu 2020; Edmans 2012; Hassel, Nilsson, and Nyquist 2005; Qureshi et al. 2020; Zhang and Vigne 2021). However, their results are mixed. Some (Qiu, Shaukat, and Tharyan 2016) do not find any relationship, whereas others confirm that ESG positively impacts firm performance (Albitar et al. 2020). Empirical studies also investigate corporate governance's role in CSR and ESG disclosure (Aguilera et al. 2006; Bear, Rahman, and Post 2010; Cucari, Esposito De Falco, and Orlando 2018; Flammer, Hong, and Minor 2019; Gerged et al. 2021; Harjoto and Jo 2011; Iatridis 2013; Jo and

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Harjoto 2012; Li et al. 2018; Qureshi et al. 2020; Sun et al. 2010). However, the climate governance concept is relatively new, and empirical studies investigating climate governance's role in financial and non-financial disclosures are scarce (Bui, Houqe, and Zaman 2020; Obergassel, Hermwille, and Oberthür 2021). Climate governance may include efforts to reduce greenhouse gas emissions (Light and Skinner, 2021). Qureshi, Ahsan, and Gull (2022) argue that eco-innovation reduces corporate carbon emissions. Shahab et al. (2022) observe that traditional corporate governance mechanisms reduce waste generation. Albitar et al. (2022) argue that better environmental governance reduces carbon emissions. Accordingly, we contribute to the emerging climate governance literature by investigating climate governance's impact on firms' waste disclosure.

Based on stakeholder theory, firms are encouraged to voluntarily disclose non-financial information to satisfy stakeholders (Freeman 1984). In light of stakeholder theory, firms can use waste disclosure to signal environmental or sustainability performance in response to stakeholder pressure. Bui, Houqe, and Zaman (2020) provide evidence that climate governance allows firms to better demonstrate their commitment to addressing sustainability issues and transparent reporting to stakeholders. Therefore, this study investigates climate governance's impact on waste disclosure using data from U.S. non-financial firms (2002–2019), as the U.S. was the top generator of plastic waste in 2016 (*National Academies of Sciences, Engineering, and Medicine* 2021). Further, to study waste management, we focus on U.S. non-financial firms for two main reasons. First, several environmental regulations aim to administer waste management practices in the U.S. (Aslam, Huang, and Cui 2020). These regulations pressure companies to manage their waste responsibly and may impact waste management practices and disclosure. Second, the U.S. is one of the largest economies worldwide and has the world's largest GDP. Studying U.S. non-financial

firms can enhance our understanding of corporates' role in this context, including efforts aimed at improving sustainability practices and addressing waste challenges by enhancing waste reporting.

To the best of our knowledge, this is the first study to investigate corporate climate governance's impact on corporate waste disclosure. This study contributes to the literature as follows. First, we find that efficient corporate climate governance increases firms' waste disclosure, irrespective of waste disclosure type (hazardous or non-hazardous). Further, corporate climate governance improves firms' waste disclosure through several channels. Second, adding to the corporate voluntary disclosure literature, we find that higher waste disclosure decreases firms' market performance. Third, we find that climate governance quality has a significant positive moderating role in the relationship between waste disclosure and firms' market performance; higher climate governance quality diminishes waste disclosure's deteriorating impact and positively contributes to firms' market performance. These results are robust to different proxies for waste disclosure, alternative regression techniques, and endogeneity issues.

The remainder of this article is organized as follows. Section 2 reviews the relevant literature and presents our research hypothesis. Section 3 describes our data, sample selection criteria, and research methods. Section 4 presents the main empirical results and additional analysis results. Section 5 concludes this study.

2. Literature review and hypothesis development

2.1 Background and relevant literature

Recently, corporate environmental responsibility (CER) has received widespread public attention, and there has been a considerable increase in research on CER-related issues (e.g. environmental performance, sustainability, waste disclosure, carbon emissions, and climate change) (Benjamin et al. 2020; Bui, Houqe, and Zaman 2020; Dahlmann, Branicki, and Brammer 2019; Karim,

Albitar, and Elmarzouky 2021; Li, Liao, and Albitar 2020; Qureshi et al. 2020). Therefore, well-reputed and highly visible corporates are focusing more on the potential negative effects of environmental issues (Garcia, Mendes-Da-Silva, and Orsato 2017; Qureshi et al. 2020). CSR or sustainability reporting is becoming an important tool for corporates to display their responsibility and accountability to stakeholders (Al-Shaer 2020; Birkey et al. 2016; Hollindale et al. 2019).

As global waste generation rates are increasing, the issue of corporate waste management is becoming more prominent, and firms are improving their non-financial disclosure reporting owing to social pressure (da ROSA et al. 2015). Corporates may have to bear potential political and economic costs if they are considered environmentally irresponsible (Laplante and Lanoie 1994). However, corporates may gain a competitive advantage by recycling waste into profitable products and complying with environmental regulations (Matsumura, Prakash, and Vera-Muñoz 2014). For example, managers may provide additional waste information to enhance community support and build relationships with regulators, which may help firms obtain cheaper capital and improve their reputation as socially responsible businesses. Thus, firms can effectively demonstrate their ability to measure and manage waste by disclosing their waste levels to the public (Benjamin et al. 2020). However, the quality and level of financial and non-financial information disclosures depend on corporate governance mechanisms.

Corporations are under increasing pressure to report their waste and take responsibility for their business activities' environmental and social impacts (Arena, Azzone, and Mapelli 2018; Bui and De Villiers 2017; Bui, Houqe, and Zaman 2020). Various empirical studies investigate corporate governance's impact on corporate financial and non-financial disclosures (Aboagye-Otchere, Bedi, and Ossei Kwakye 2012; Forker 1992; Gerged et al. 2021; Hermalin and Weisbach 2012; Mallin, Michelon, and Raggi 2013; Shan 2019; Sharma, Panday, and Dangwal 2020). However,

empirical evidence on corporate climate governance's role in determining corporate waste disclosure is lacking (Bui, Houqe, and Zaman 2020).

2.2 Climate governance and corporate waste disclosure

Previous research regarding corporate social or environmental responsibility and sustainability disclosures is mainly dominated by stakeholders and signalling theories (Bin-Feng et al. 2022; Bui, Houqe, and Zaman 2020; Cormier and Magnan 1999; Jiang and Fu 2019; Nishitani et al. 2021; Qureshi et al. 2020; Yin and Wang 2018). According to stakeholder theory, managers are responsible for all stakeholders (Berle and Means 1932; Freeman 1984; Freeman 2010). Based on this theory, stakeholders reward firms that engage in environmental or social non-profit activities (Buallay 2019; Lokuwaduge and Heenetigala 2017; Qureshi et al. 2020). According to signalling theory, disclosing socially responsible activities may signal the superior CSR performance of these firms, thereby giving them a competitive advantage (Clarkson et al. 2008). Firms with strong climate governance may provide more information on climate-related issues (including waste disclosure) and use sustainability reporting to communicate with stakeholders (Bui, Houqe, and Zaman 2020).

Empirical studies investigate the impact of various governance dimensions on CSR, environmental, and sustainability performance. Using data on 469 U.S. firms, Berrone and Gomez-Mejia (2009) investigate the link between executive compensation and environmental performance. They conclude that firms with environmental committees and explicit environmental pay policies are similar to those without these structures in terms of rewarding environmental strategies. Liao, Luo, and Tang (2015) investigate the impact of board diversity, independence, and environmental committees on greenhouse gas disclosure using a sample of 329 U.K. firms. They observe that firms with more independent boards and those with environmental committees

tend to be more ecologically transparent. Peters and Romi (2015) observe that the presence of a Chief Sustainability Officer in U.S. firms is positively associated with corporate sustainability report assurance. Haque (2017) examine the impact of board attributes and sustainable compensation policy on the carbon performance of 256 non-financial U.K. firms and observe a positive association of board diversity, board independence, and sustainable compensation policy with carbon reduction initiatives. Husted and de Sousa-Filho (2017), while investigating sustainability governance's impact, observe that all sustainability governance types help improve corporate ESG performance. Maas (2018) do not find a link between corporate social performance and corporate social performance targets to determine executive compensation. However, Baraibar-Diez Odriozola and Fernández Sánchez (2019) observe that sustainable compensation policies improve the ESG scores of firms operating in France, Germany, Spain, and the U.K. Several studies discuss the interaction between corporate governance and regulatory disclosure regimes. For example, Skinner (2019) explores how banks (given their particular economic roles) invest a socially optimal amount of resources in cybersecurity and cyber disclosure's effectiveness in addressing social interest in banks' cyber risk. Light and Skinner (2021) discuss how banks can and should address climate change. Albitar Al-Shaer and Liu (2023) study climate governance's impact on corporate commitment to climate change and argue that companies that integrate climate issues into governance can address climate change risks and are more committed to climate change.

This study uses an index to measure corporate climate governance based on five climate governance dimensions (ESG compensation, sustainability compensation, sustainability committee, sustainability reporting, and sustainability audit). A higher score for this composite

index indicates better climate governance and vice versa. Therefore, in light of stakeholder and signalling theories and the empirical evidence, we postulate the following hypothesis:

H1: *There is a positive association between corporate climate governance and waste disclosure of U.S. firms.*

3. Data, variables, and methodology

3.1 Data and variables

We collect data using Asset4 and WorldScope, as they provide sufficient data related to waste produced and climate governance variables (Bui, Houqe, and Zaman 2020; Garcia, Mendes-Da-Silva, and Orsato 2017; Qureshi et al. 2020; Vastola, Russo, and Vurro 2017). We only include listed U.S. non-financial firms and firms for which waste production, climate governance, and other firm-level control variables are available. We finalize a dataset of 1,829 firm-year observations from 2002[3] to 2019.

We measure waste (*WST*) as the natural logarithm of total waste produced and disclosed in tons (Benjamin et al. 2020). We also use alternative proxies (hazardous waste [*H_WST*], non-hazardous waste [*N_WST*], total waste scaled by total assets [*WST/ASSETS*], and total waste scaled by net sales [*WST/SALES*]) to measure waste. To measure climate governance (*CLIM_GOV*), we follow Bui, Houqe, and Zaman (2020) and use a composite score obtained by adding five climate governance components: ESG compensation (*ESG_COMP* - Dummy variable coded 1 if the firm has an ESG compensation policy and 0 otherwise), sustainability compensation (*SUS_COMP* - Dummy variable coded 1 if executives' compensation is associated with sustainability

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[3] We start sample data collection from 2002 because of unavailability of waste data for earlier years and end in 2019 so that we can avoid the COVID-19 pandemic's impact, which may have a substantial effect on waste production and recycling levels due to reduced economic activity globally.

performance and 0 otherwise), sustainability committee (*SUS_COM* - Dummy variable coded 1 if the firm has a sustainability committee and 0 otherwise), sustainability reporting (*SUS_REP* - Dummy variable coded 1 if the firm issues a separate sustainability report and 0 otherwise), and sustainability audit (*SUS_AUDIT* - Dummy variable coded 1 if the sustainability report is validated by a third-party auditor, and 0 otherwise). A higher score indicates a better climate governance quality and vice versa.

We also use several corporate governance and firm-level control variables that are normally associated with sustainability disclosure or performance (Ahsan and Qureshi 2021; Benjamin et al. 2020; Bui, Houqe, and Zaman 2020; Kraus, Rehman, and García 2020; Meng et al. 2014). These include board size (*BD_SIZE*), board independence (*BD_IND*), board gender diversity (*BD_GENDER*), research and development intensity (*RD_INT*), cash flows (*CASH_TA*), financial leverage (*LEV*), profitability (*TQ*), financial loss (*LOSS*), and firm size (*SIZE*). Table 1 presents the variables used in this study.

[Insert Table 1 Here]

3.2 Methodology

We develop Equation 1 to investigate climate governance's (*CLIM_GOV*) impact on the waste disclosure of U.S. firms (H1). Our baseline equation is as follows:

$$WST_{it} = \beta_0 + \beta_1 CLIM\_GOV_{jt} + \beta_2 Controls_{it} + Industry_i + Year_t + \varepsilon_{it}, \qquad (1)$$

where WST_{it} represents one of the five different measures of waste disclosure (WST_{it}, H_WST_{it}, N_WST_{it}, $WST_{it}/ASSETS_{it}$, and $WST_{it}/SALES_{it}$) of firm i at time t. $CLIM\_GOV_{it}$ represents an index-based score to measure firm i's climate governance quality at time t. $Controls_{it}$ represents three corporate governance (*BD_SIZE, BD_IND, and BD_GENDER*) and

seven firm-level control variables (*RD_INT, CAP_INT, CASH_TA, LEV, TQ, LOSS, and SIZE*) of firm i at time t as defined in Table 1. The dummy variables $Industry_i$ and $Year_t$ control for industry and time fixed effects, respectively. ε_{it} is the error term for firm i at time t.

4. Empirical results

4.1 Descriptive statistics

Table 2 presents the summary statistics. The mean value of 10.860 for *WST,* with minimum and maximum values of 5.258 and 17.453, respectively, indicates that the sample firms' waste disclosure scores vary. The mean value of 3.132 for *CLIM_GOV* indicates that, on average, the sample firms' climate governance scores are good; although, the minimum (0.000) and maximum (5.000) values indicate that some firms have high climate governance quality while others have low climate governance quality. The mean value of 2.396 for *BD_SIZE,* with a standard deviation of 0.213, indicates that, on average, the sample firms' board sizes are almost the same. The mean value of 0.868 for *BD_IND* and 0.203 for *BD_GENDER* explain that, on average, more than 80% of the directors of the sample firms are independent and more than 20% are female. The mean value of 0.045 for *RD_INT,* with a standard deviation of 0.069, and the mean value of 0.091 for *CAP_INT,* with a standard deviation of 0.143, indicate high variations in the sample firms' research and development and capital intensities. The mean values of 0.125 and 0.299 for *CASH_TA* and *LEV*, respectively, indicate that, on average, the sample's cash reserves are more than 10% of their total assets and almost 30% of their assets are financed by debt. The mean of 2.055 for *TQ* indicates that the sample firms' average market values are almost double their book values. The mean value of 0.072 for *LOSS* shows that 7.2% of the sample firms report negative earnings. The mean value of 16.731 for *SIZE,* with minimum and maximum values of 12.571 and 19.254, respectively, indicates that the sample firms' sizes vary.

4.2 Correlation matrix

Table 3 presents the results of pairwise correlations. A significant positive correlation (0.231*) is found between *CLIM_GOV* and *WST,* which supports H1 and indicates that high climate governance quality improves corporate waste disclosure. Additionally, *BD_SIZE* (0.216*), *BD_IND* (0.122*), and *BD_GENDER* (0.053*) have a significant positive correlation with *WST*, indicating that firms with large, independent, and gender-diverse boards are more likely to disclose waste data. Further, *RD_INT* (-0.313*) and *CAP_INT* (0.060*) have significant negative and positive correlations with *WST*, respectively, suggesting that research and development-intensive firms have lower waste disclosure, while capital-intensive firms have higher waste disclosure. Moreover, *CASH_TA* (-0.346*) and *LEV* (0.206*) have significant negative and positive correlations with *WST,* respectively, suggesting that firms with higher cash ratios have lower waste disclosure, while firms with higher debt ratios have higher waste disclosure. Lastly, *SIZE* (0.294*) has a significant positive correlation with *WST*, indicating that large firms have higher waste disclosure.

4.3 Hypothesis testing

Table 4 presents the results of the regression analysis that investigates climate governance quality's impact on waste disclosure. Different models' results are reported, controlling for industry, year, and cluster effects. A consistent significant positive association exists between *CLIM_GOV* and *WST* in all models, supporting H1. This indicates that firms' high climate governance quality improves their waste disclosure. These findings are consistent with the results of Bui, Houqe, and

Zaman (2020), who suggest that firms with an efficient climate governance structure have higher carbon disclosure.

The board structure control variables, *BD_SIZE* (Models 1 and 3), *BD_IND* (Model 1), and *BD_GENDER* (Model 2–4), have a significant positive association with *WST*, suggesting that large, independent, and gender-diverse boards improve waste disclosure. These findings contradict the results of Bui, Houqe, and Zaman (2020), who suggest that traditional corporate governance has an insignificant impact on carbon disclosure. The firm-level control variables, *RD_INT* and *CASH_TA*, have a consistent significant negative association with *WST*, indicating that firms' research and development and capital intensities reduce waste disclosure. However, the positive association of *CAP_INT* (Models 2, 3, and 5) with *WST* suggests that capital-intensive firms have higher waste disclosure. Further, *LEV* and *SIZE* have a consistent significant positive association with *WST*, implying that large and debt-intensive firms have higher waste disclosure. Lastly, *TQ* has a consistent significant negative association with *WST*, indicating that firms' high market valuation decreases waste disclosure. *LOSS* does not have any significant relationship with *WST*.

[Insert Table 4 Here]

4.4 Results using alternate measures of waste

Table 5 presents the results of examining climate governance quality's impact on firms' waste disclosure using four different proxies. Columns (1) and (2) use two components (hazardous and non-hazardous waste disclosures) as dependent variables to investigate climate governance quality's impact on hazardous (*H_WST*) and non-hazardous (*N_WST*) waste disclosures. *CLIM_GOV* has a moderately significant positive association with *H_WST* (0.290**) and *N_WST* (0.233**), suggesting that high climate governance quality improves the disclosure regardless of whether the waste is hazardous or non-hazardous. Columns (3) and (4) use the ratio of waste to

total assets (*WST/ASSETS*) and the ratio of waste to net sales (*WST/SALES*), respectively, as two additional alternative proxies for waste disclosure. *CLIM_GOV* has a significantly positive association with *WST/ASSETS* (0.116**) and *WST/SALES* (0.265**). Consistent with the main results in Table 4, these findings suggest that high climate governance quality improves waste disclosure.

[Insert Table 5 Here]

4.5 Channel analysis

Tables 6 and 7 present the subsample analysis results based on CSR performance, environmental performance, corporate governance quality, level of waste produced, and industry nature, because firms' tendency to disclose waste data may vary based on these dimensions. Therefore, these analyses may help clarify the channel through which climate governance quality affects waste disclosure. Table 6 reports the results of the regression analysis that examines the roles of CSR performance, environmental performance, and corporate governance quality in determining the relationship between climate governance and waste disclosure. We split our sample based on Asset4 CSR performance, environmental performance, and corporate governance quality scores. We consider firms as high CSR oriented (*High CSR*), high environmentally oriented (*High ENV*), and displaying high corporate governance (*High CG*) if the Asset4 CSR performance, environmental performance, and corporate governance quality scores, respectively, are higher than the industry-year average; otherwise, they are considered as low CSR oriented (*Low CSR*), low environmentally oriented (*Low ENV*), and displaying low corporate governance (*Low CG*). *CLIM_GOV* has a highly positive and significant association with *WST* for the subsample of *High CSR*, *High ENV*, and *High CG* firms. By contrast, *CLIM_GOV* has no significant association and *WST* for the subsample of *Low CSR*, *Low ENV*, and *Low CG* firms. Therefore, we infer that the

positive association between climate governance quality and waste disclosure is subject to firms' CSR orientation, environmental orientation, and governance quality.

[Insert Table 6 Here]

Table 7 reports the results of the regression analysis that examines the role of the level of waste produced and industry nature in the relationship between climate governance and waste disclosure. We create different subsamples based on the level of waste produced and industry nature. Firms are classified as high waste producing (*High Waste*) if the level of waste produced is higher than the industry-year average; otherwise, they are considered as low waste producing (*Low Waste*). Following extant studies (Cho & Patten 2007; Cho et al. 2010; Gull et al. 2023), we consider the chemical, metal, mining oil exploration, paper, petroleum, and electric industries as environmentally sensitive (*Sensitive*) and other industries as non-sensitive (*Non-Sensitive*). A positively significant association exists between climate governance and waste disclosure across all subsamples, suggesting that climate governance quality improves waste disclosure, irrespective of the level of waste produced by the sample firms and industry nature.

[Insert Table 7 Here]

4.6 Addressing endogeneity

Our findings using OLS regressions, which are reported in Table 4, may be subject to potential endogeneity because of selection bias, reverse causality, or dynamic panel endogeneity. Selection bias implies that higher waster disclosure may be due to firm-specific factors such as corporate governance characteristics or firm-level control variables other than climate governance quality. Therefore, we follow extant studies (Benjamin et al. 2020; Gull et al. 2018; Gull et al. 2021; Nadarajah et al. 2021; Nadeem, Gyapong, and Ahmed 2020) and use propensity score matching

(PSM) and a two-step Heckman regression (Heckman) to address selection bias. We also use two-stage least squares (2SLS) and system generalized method of moments (GMM) estimations to address potential endogeneity due to reverse causality and dynamic panel endogeneity (Benjamin et al. 2020; Gull et al. 2021; Nadarajah et al. 2021; Nadeem, Gyapong, and Ahmed 2020).

The observed relationship between *WST* and *CLIM_GOV* may be biased because of differences in firm-level characteristics, such as firm size, level of financial leverage, or cash holdings (Gull et al. 2023). To address this issue, we apply PSM. First, we create a treatment dummy variable (*CLIM_DUMMY*), which takes the value of 1 if firms' climate governance scores are higher than the sample average and 0 otherwise. Based on *CLIM_DUMMY*, we define firm years with climate governance quality higher and lower than the sample average as the treatment and control groups, respectively. We then estimate the predicted value of effective climate governance practices by estimating a logit regression for *CLIM_DUMMY* on the control variables used in Equation 1 and compute the propensity scores for all firms. Next, we create two similar subsamples based on different criteria (i.e. the treatment and control groups) using propensity scores. Finally, we obtain a matched sample that includes firm years that are similar, based on firm-level characteristics[4], to investigate climate governance's impact on waste disclosure. We re-estimate Equation 1 on the matched sample; Table 8 (Model 3) reports the results. The results are in line with those reported in the main analysis (Table 4), reaffirming that the positive association between climate governance and waste disclosure is not due to firm-specific factors. Hence, our main results are not subject to such concerns.

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[4] The results documented under Model 1 of Table 4 show that several firm-level variables are significantly associated with *CLIM_DUMMY* but none of the firm-level variables is significantly associated with *CLIM_DUMMY* in Model 2. This suggests that the firm years included in the matched sample are indifferent based on the control variables and matching is performed correctly.

We employ 2SLS estimations to address potential endogeneity that may arise because of reverse causality. Following Benjamin et al. (2020), we use one-year lagged values (*LAG_CLIM_GOV*) and the industry average (*CLIM_GOV_IA*) of the independent variable (*CLIM_GOV*) (*WST_IA* & *R_WST_ IA*) as instrumental variables to perform 2SLS estimations. Both instruments are likely to meet the exclusion criterion by (not) being correlated with quality climate governance practices (dependent variables, i.e. *WST*). Model 6 of Table 8 presents the first-stage results, in which *CLIM_GOV* is the dependent variable. In Model 6, we control for all variables used in Equation 1, including industry and year effects. The coefficients of *LAG_CLIM_GOV* and *CLIM_GOV_IA* are positive and statistically significant at the 1% level. The *p-value* of the Hansen test of over-identification is also insignificant, implying that the instruments are valid. Model 7 reports the second-stage results using the predicted value *CLIM_GOV* from the first-stage model to estimate

waste disclosure. A significantly positive association exists between *CLIM_GOV* and *WST,* suggesting that our findings do not suffer from reverse causality.

Finally, we use the system GMM approach, which accounts for dynamic panel endogeneity, by running two equations (Gull et al. 2023; Roodman 2009). The system GMM runs an equation at the level in which first-differenced variables are used as instruments, and another equation in first differences, where the levels of the variables are used as instruments. Model 8 of Table 8 shows that the first-order autocorrelation (AR[1]) test is significant, indicating that the residuals are serially correlated. By contrast, the test for the second-order autocorrelation (AR[2]) is insignificant, indicating that the second-difference residuals are not serially correlated. Finally, the *Hansen J-statistic* of over-identifying restrictions is insignificant, suggesting acceptance of the null hypothesis that our instruments are valid and our model is statistically well-fitted. The system GMM results show that climate governance has a positively significant association with waste disclosure. The results in Table 8 suggest that our main findings are not biased because of endogeneity.

[Insert Table 8 Here]

4.7 Further analysis

Our main findings suggest that climate governance enhances waste disclosure. However, it is also important to know whether stakeholders (stock markets) react positively to higher waste disclosure (Gull et al. 2022) because of the better climate governance practices employed by the sample firms. Specifically, we examine the implications of waste disclosure on financial performance and test whether it is beneficial for firms to disclose waste data when effective climate governance practices are implemented.

To answer this question, we use the following equation.

$$PERFORMANCE_{it}$$

$$= \beta_0 + \beta_1 CLIM\_GOV_{jt} + \beta_2 WST_{it} + \beta_2 CLIM\_GOV \; X \; WST_{it}$$

$$+ \beta_3 Controls_{it} + Industry_i + Year_t + \varepsilon_{it}, \qquad\qquad (2)$$

where *PERFORMANCE* is the firms' financial performance, measured using return on assets (*ROA*) and Tobin's q (*TQ*). *Controls* represent control variables, as specified in Equation 1. The variable of interest is *CLIM_GOV X WST*. If waste disclosure by firms with better climate governance practices offsets the firms' financial performance, then the coefficient of *CLIM_GOV X WST* should be positive and statistically significant. The results in Table 9 (Model 2) show that the coefficients of *WST* and *CLIM_GOV* are negatively significant for *TQ*, suggesting that waste disclosure and climate governance negatively affect firms' financial performance. However, the coefficient of *CLIM_GOV X WST* is positively significant for *TQ*, suggesting that waste disclosure by firms with better climate governance quality is positively associated with financial performance measured by *TQ*, which is a market-based measure of financial performance. However, *WST, CLIM_GOV,* and *CLIM_GOV X WST* have an insignificant relationship with *ROA*. These results suggest that the implementation of effective climate governance mechanisms offsets waste disclosure's negative impact and positively contributes to firms' market performance through waste disclosure. This finding may motivate firms to deploy effective climate governance practices and enhance the disclosure of business activities on the environment.

[Insert Table 9 Here]

5. Conclusion

Owing to the growing interest in sustainability and climate-related issues among stakeholders, firms are becoming increasingly concerned about voluntary waste disclosure. This study

acknowledges the growing importance of waste disclosure and provides the first empirical evidence of climate governance's impact on waste disclosure. Based on a sample of 1,829 U.S. non-financial firm-year observations from 2002 to 2019, we find that high-quality climate governance enhances the level of waste disclosure (including hazardous and non-hazardous waste disclosures). Further, climate governance quality affects waste disclosure through several channels such as firms' level of CSR orientation, environmental orientation, and governance quality. Additionally, higher waste disclosure and climate governance reduce firms' market performance. Finally, climate governance quality has a positive moderating effect on the relationship between firms' waste disclosure and market performance. This suggests that climate governance quality improves firms' market performance through waste disclosure.

This study has potential managerial and policy implications. Our findings may help regulators understand what drives waste disclosure, as climate governance and some traditional governance dimensions significantly impact the waste disclosure level. Our findings indicate that traditional governance mechanisms are important for waste disclosure; although, climate governance drives such disclosures. Consequently, regulators must encourage companies to improve their climate governance quality, which in turn improves their environment-related disclosure quality. This study may also benefit managements, as it proves that climate governance quality moderates the relationship between waste disclosure and market performance. These findings can be helpful for an informed cost-benefit analysis of high-quality climate governance and an enhanced waste disclosure program.

However, this study has some limitations. First, our sample is limited to U.S. non-financial firms. Therefore, our findings may not be applicable to other countries where governance and environmental disclosure practices may differ. Second, although we use several techniques to

address endeneity, it is impossible to completely rule out such concerns. Third, our measure of waste disclosure is the waste produced and disclosed in tons. We do not consider waste disclosure statements in the narrative sections of annual reports; thus, we cannot identify the tone in and readability of waste disclosure. Future research should address these limitations.

Further research can examine different topics such as climate governance's impact on waste disclosure in other contexts, waste information in corporate narrative reports and its relationship with waste produced and disclosed in tons, and the quality of waste disclosure statements (e.g. tone and readability). Our study highlights the importance of climate governance and waste disclosure for firm valuations. Therefore, future research could examine their impact on stock prices, cost of capital, analyst forecast errors, analyst coverage, investment efficiency, levels of cash holdings, and corporate dividend policy. Finally, Alkaraan et al. (2022) find that ESG indicators moderate the relationship between corporate transformation towards Industry 4.0 (CTTI4.0) and firm performance. They argue that reducing and managing waste is a key issue related to CTTI4.0. Thus, further research could test whether the waste produced and disclosed in tons is influenced by CTTI4.0.

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