



Female parliamentarians and environmental sustainability: Do national culture matter?

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ARTICLE INFO

Keywords:

Female parliamentarians
Environmental sustainability
Women in politics
Culture

ABSTRACT

This study examines how cultural contexts shape the relationship between female parliamentarians and environmental sustainability. Drawing on institutional theory, we argue that the impact of women in parliament on environmental outcomes depends on the cultural environment in which they operate. Using data from 18 countries over 20 years, we apply robust econometric techniques, including two-stage ordinary least square (2SLS), system-generalised method of moments (S-GMM), instrumental variable generalized method of moments (IV-GMM), and ordinary least squares (OLS), and use green growth to measure environmental sustainability. Our findings reveal that female parliamentarians positively influence environmental sustainability in countries with a long-term orientation and individualist cultures. However, cultural factors such as power distance, masculinity, and uncertainty avoidance limit their impact. This study advances the debate on the female leadership-environmental nexus by highlighting the role of culture. The results imply that, beyond appointing women, countries must cultivate cultural support to maximize their contributions to environmental sustainability.

1. Introduction

The escalating challenges of climate change and its accompanying natural disasters have shifted global attention from merely reducing carbon emissions to assessing countries' strategies for achieving environmental sustainability (OECD, 2020). The formulation and implementation of these strategies lie in the hands of national leaders, including parliamentarians (Tawiah, 2022). The existing literature has explored how political diversity influences environmental outcomes. For instance, differences in political ideologies explain variations in countries' environmental quality (Lundquist, 2024; Tawiah, 2022). Similarly, gender diversity has been shown to impact environmental outcomes (Ergas and York, 2012; Lv et al., 2022; Mavisakalyan and Tarverdi, 2019). Ergas and York (2012) found that higher female participation in politics correlates with reduced CO₂ emissions. However, other studies present mixed results. For example, Jones (1997) in Latin America observed no significant gender differences on environmental issues, and Tremblay (1998) reported that male

parliamentarians were more influential in shaping environmental policies than their female counterparts.

While existing studies offer valuable insights into the role of female politicians in environmental governance, they predominantly examine direct relationships while paying limited attention to the cultural and societal contexts that shape these dynamics (Johnson et al., 2013; Naghavi et al., 2021). The assumption that national culture uniformly mediates the impact of female leadership on sustainability overlooks critical variations in how different societies enable or constrain women's political agency (Sandberg and Alvesson, 2011). Problematising this perspective reveals that the mere election of women into office does not guarantee substantive influence, as societal expectations and mandatory quotas often result in tokenism, where female leaders are perceived as symbolic rather than effective contributors (Green and Homroy, 2018; Torchia et al., 2011). By interrogating these assumptions, the study controls for Western-centric biases in gender-environment research and moves beyond deterministic cultural frameworks that dominate current literature. Cultural dimensions such as power distance, masculinity, and

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<https://doi.org/10.1016/j.techfore.2025.124174>

Received 9 August 2023; Received in revised form 21 April 2025; Accepted 23 April 2025

Available online 30 April 2025

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uncertainty avoidance play a pivotal role in determining whether female parliamentarians can effectively advocate for sustainability policies. For instance, [Naghavi et al. \(2021\)](#) demonstrate that in high power distance, masculine, and individualist cultures, female leaders face greater barriers in asserting their influence, challenging the essentialist notion that women's representation automatically translates to progressive environmental outcomes.

This critique necessitates a reframing of the research question beyond whether national culture moderates this relationship, to instead investigate how specific cultural dimensions - such as those outlined by Hofstede - interact with institutional structures to enable or constrain female MPs' environmental advocacy ([Sandberg and Alvesson, 2011](#)). The research question - how cultural attributes moderate the relationship between female parliamentarians and environmental sustainability - emerges from this critical examination of existing literature's limitations. The "why" addresses the need to understand why some nations with high female representation achieve stronger sustainability outcomes than others, moving beyond simple correlation analyses. The "what" investigates how specific cultural dimensions (Hofstede's framework) and institutional factors interact to enable or constrain women's environmental leadership. The "how" employs comparative case analysis to examine these dynamics across different cultural and political contexts, providing a more nuanced understanding than aggregate national-level studies. This approach reveals that the relationship between gender and environmental policy is not universal but contingent on complex intersections of cultural norms, political systems, and institutional barriers.

By incorporating these insights, the study advances towards a critical institutional analysis that accounts for the intersection of cultural norms, power dynamics, and gendered expectations in environmental governance. This not only challenges reductionist binaries but also provides a more nuanced understanding of the conditions under which female leaders can effectively promote sustainability, particularly in contexts where their voices are systematically marginalized ([Greene et al., 2020](#)). Ultimately, this problematization reveals the need for research that interrogates not just the presence of women in politics, but the complex interplay of cultural, institutional, and socioeconomic factors that determine their actual policy influence.

Institutional theory posits that organizations and institutions, including legislative bodies, are shaped by the societal and cultural environments in which they operate ([Scott, 1987](#)). Female parliamentarians, as key political actors, are expected to act within the constraints and opportunities of their socio-cultural settings ([Conyon & He, 2017](#); [Naghavi et al., 2021](#)). Consistent with this theory, we argue that the influence of female parliamentarians on environmental sustainability reflects the cultural contexts in which they function. Thus, we hypothesize that the relationship between female parliamentarians and environmental sustainability varies significantly across different cultural dimensions.

To test this hypothesis, we use data from 18 democratic countries over 20 years, employing green growth metrics from the OECD to measure environmental sustainability. Unlike prior studies (e.g., [Ergas and York, 2012](#); [Lv et al., 2020, 2022](#); [Mavisakalyan and Tarverdi, 2019](#)) that relied on carbon emissions as a proxy for environmental outcomes, green growth offers a more comprehensive measure, reflecting the efficiency of economic growth in reducing environmental degradation ([OECD, 2020](#)). To quantify cultural settings, we apply Hofstede's six cultural dimensions ([Chan and Cheung, 2012](#); [Disli et al., 2016](#); [Gyapong and Afrifa, 2019](#)) and employ robust econometric techniques, including S-GMM and IV-GMM, to test our hypotheses.

Our results reveal a positive and significant relationship between female parliamentarians and environmental sustainability. However, the impact varies across cultural dimensions. Specifically, we find that high power distance, masculinity, and uncertainty avoidance act to limit the influence of female parliamentarians on environmental sustainability. These dimensions are often characterized by male dominance

and stereotyping, which constrain women's effectiveness in decision-making roles. In contrast, long-term orientation and individualism enhance the positive impact of female parliamentarians, as these cultural attributes encourage independent thinking and empower individual agency. However, indulgence does not exert a significant influence on this relationship. These findings underscore the importance of cultural settings in shaping the effectiveness of female parliamentarians in promoting environmental sustainability.

Our study advances the literature on gender and environmental governance by incorporating cultural contexts, a factor often overlooked in prior research. Unlike earlier studies, which primarily focused on direct effects, we highlight how societal norms influence the extent to which female parliamentarians can contribute to environmental outcomes ([Gyapong and Afrifa, 2019](#)). Additionally, our use of green growth as a measure of environmental sustainability provides a more nuanced perspective than traditional carbon emission metrics. Green growth accounts for the efficiency of natural resource use alongside economic development, aligning with OECD guidelines that emphasize sustainable growth without compromising economic progress ([OECD, 2020](#); [Tawiah et al., 2021, 2023](#)).

From a policy perspective, our findings emphasize the need for countries to foster cultural environments that empower women in leadership roles. The results suggest that legislative bodies, particularly in democratic nations, play a pivotal role in setting the agenda for environmental governance. Gender diversity within these bodies enhances the inclusivity and comprehensiveness of environmental policies, especially in areas like renewable energy and climate change mitigation ([Ergas and York, 2012](#); [Lv et al., 2022](#); [Mavisakalyan and Tarverdi, 2019](#)). While female parliamentarians contribute significantly to environmental sustainability, their impact is mediated by the cultural contexts in which they operate. Policymakers and stakeholders must prioritize cultural reforms that support gender equity and inclusivity, thereby enabling female leaders to champion environmental initiatives. This study calls for a deeper integration of cultural factors into future research on gender and environmental governance, offering new directions for policy development and institutional reform.

The remainder of the paper is organized as follows: Section 2 is a literature review that discusses how the different cultural dimensions could affect the relationship between female parliamentarians and environmental sustainability; Section 3 presents the research methods; Section 4 contains the results and discussion; Section 5 concludes the paper with policy implications and suggestions for future research.

2. Literature review

Regardless of a country's level of democracy, cultural settings play a crucial role in determining how various types of parliamentarians influence national outcomes. While the increasing participation of women in politics is promising, it is important to note that not all cultures are equally supportive of female leadership. In certain cultures, women may be overshadowed, resulting in their roles being relegated to token positions. Culture, defined as the shared beliefs, values, knowledge, and goals that guide actions, is embodied through different dimensions ([Hofstede, 2001](#); [Milton, 1997](#)). [Hofstede \(1994, 2001\)](#) consolidated these aspects into six dimensions, which have since become the dominant framework for measuring culture in the literature. Consistent with prior research ([Chan and Cheung, 2012](#); [Disli et al., 2016](#); [Gyapong and Afrifa, 2019](#)), we adopted Hofstede's six dimensions to explore how culture may influence the relationship between female parliamentarians and environmental sustainability.

2.1. Individualism v. collectivism

In individualistic cultures, personal benefits and those of immediate families are highly valued ([Onel and Mukherjee, 2014](#); [Ringov and Zollo, 2007](#); [Triandis, 2018](#)). In such societies, individual efforts are

recognized and celebrated (Hofstede, 2010). Conversely, collectivist cultures prioritize the greater good of society over individual gains, where responsibilities are shared, and actions have collective implications (Onel and Mukherjee, 2014).

Individualism promotes self-empowerment and personal accountability, making individual rights and responsibility towards the environment particularly salient. An individualistic society is more likely to empower women to excel in environmental policy implementation, as individual efforts are acknowledged and rewarded. In contrast, collectivist societies may be less likely to recognize or support individual contributions, especially those of women in leadership positions. Given the historical male dominance in politics and policy, female parliamentarians in individualist cultures may be motivated to advance environmental sustainability initiatives. Therefore, we hypothesize:

H1. A higher level of individualism positively moderates the association between female parliamentarians and environmental sustainability.

2.2. Uncertainty avoidance

Uncertainty avoidance refers to the degree to which people feel threatened by uncertain or ambiguous situations, with high uncertainty avoidance cultures being more conservative and resistant to change (Chan and Cheung, 2012; Gyapong and Afrifa, 2019). These societies tend to uphold the status quo and may be less receptive to foreign or new practices, such as women in leadership roles or environmental sustainability initiatives (Kale, 1991; Kale and Barnes, 1992). In such cultures, resistance to change may extend to women's involvement in environmental matters because it represents a departure from established norms.

Given that environmental protection and sustainability are relatively recent issues in many countries, and the inclusion of women in top positions is still evolving, societies with high uncertainty avoidance are less likely to embrace these changes. Including women in political decisions, particularly regarding environmental issues, requires substantial shifts in social norms (Alvarado, 2018). Therefore, we hypothesize:

H2. Uncertainty avoidance negatively moderates the relationship between female parliamentarians and environmental sustainability.

2.3. Long term v. short-term orientation

Hofstede (1994) defined long-term and short-term orientation as the extent to which societies focus on planning and the long-term consequences of actions. Societies with a long-term orientation emphasize values such as thrift, perseverance, and a focus on future outcomes (Hofstede, 2001). In contrast, societies with a short-term orientation prioritize immediate gratification and short-term gains, often disregarding the long-term effects of their actions (Disli et al., 2016; Laibson, 1997).

Women, particularly in their caregiver role, are often perceived as more future-oriented than men, which may make them more inclined to support long-term sustainability efforts (Caruso et al., 2013; Richman et al., 2011). As environmental issues often have far-reaching long-term consequences, women are likely to advocate for policies that address future needs, such as environmental sustainability. In societies with a long-term orientation, female parliamentarians are more likely to gain support for their environmental campaigns. In contrast, short-term-oriented societies may focus on the immediate costs of environmental initiatives, hindering female parliamentarians' ability to champion sustainable policies. Hence, we hypothesize:

H3. Long-term orientation positively moderates the association between female parliamentarians and environmental sustainability.

2.4. Power distance

According to Hofstede (1994), power distance reflects the extent to which members of a society accept the unequal distribution of power within institutions and organizations. In high power distance cultures, hierarchical structures foster a subordinate–superior relationship, where subordinates heavily rely on their superiors. Decision-making in such societies often prioritizes loyalty and the balance of favours over merit (Onel and Mukherjee, 2014).

These cultural norms frequently reinforce gendered hierarchies, with men perceived as superior and occupying the majority of top positions in society (Prime et al., 2009). Prior research highlights that in the political landscape, men dominate most parliaments and leadership roles (Krook and O'Brien, 2012; Wängnerud, 2009). According to the Inter-Parliamentary Union, men hold >70 % of seats in national parliaments globally, and males chair approximately 75 % of specialized parliamentary committees; it projected that between 2018 and 2025, 78.3 % of parliamentary speakers would be male (Inter-Parliamentary Union, 2025).

In high power distance countries, these structural and cultural norms may limit the voices and influence of female parliamentarians. Although women may hold formal positions in parliament, their contributions may be perceived as symbolic or tokenistic rather than substantive. Consequently, female parliamentarians in such contexts are less likely to command the respect or authority necessary to advocate effectively for environmental sustainability.

H4. High power distance negatively moderates the relationship between female parliamentarians and environmental sustainability.

2.5. Masculinity v. femininity

Masculinity refers to the extent to which society values "achievement and material success" (Hofstede, 1984), whereas femininity emphasizes the importance of care and quality of life (Husted, 2000). In masculine societies, traditional gender roles prevail, with an emphasis on assertiveness, toughness, and materialism for men (Hofstede, 2001; Onel and Mukherjee, 2014). Conversely, feminine societies place more emphasis on equality, modesty, tenderness, and respect for the quality of life for both men and women (Ringov and Zollo, 2007). In these cultures, there is minimal or no distinction between the roles and characteristics of the sexes (Heffernan and Farrell, 2005).

Hofstede (2010) further asserts that women are more likely to be elected to political positions in feminine societies. This reflects a cultural tendency to support gender equality and involve women in leadership. In contrast, masculine societies may discourage women from participating in politics, with their roles often reduced to tokenism. Consequently, their influence on environmental policies may be limited. Studies, such as that of Disli et al. (2016), suggest that masculine societies tend to exhibit high levels of carbon emissions, likely due to weaker environmental regulations and the dominance of male-oriented perspectives. Based on this, we hypothesize:

H5. A higher level of masculinity negatively moderates the relationship between female parliamentarians and environmental sustainability.

2.6. Indulgence v. restraint

Indulgence refers to the extent to which a society allows for the gratification of natural human desires, particularly the pursuit of enjoyment and leisure, while restraint involves the regulation of such gratification to conform to societal norms (Hofstede et al., 2010). Societies characterized by indulgence tend to place greater emphasis on short-term satisfaction, with less concern for long-term goals or the well-being of future generations (Alvarado, 2018). In these cultures, individuals may be less inclined to prioritize long-term sustainability, which is essential for advancing environmental policies.

Given that indulgent societies are typically more focused on immediate gratification, they may be less supportive of female parliamentarians, who are often more concerned with long-term issues, such as environmental sustainability (Alvarado, 2018). Moreover, the hedonistic attitude in indulgent societies could lead to a greater tolerance for environmental degradation in exchange for short-term satisfaction. Therefore, we hypothesize that:

H6. Indulgence negatively moderates the relationship between female parliamentarians and environmental sustainability.

3. Research methods

3.1. Data

This study used panel data from 18 nations, with the selection of countries and the study period (1997–2020) guided by the availability of data on female parliamentarians and environmental sustainability indicators. Because of data constraints, we limited our sample to countries where consistent data on female parliamentary representation was accessible. Additionally, under the premise that parliamentarians are more likely to influence national outcomes in contexts where democratic principles and the separation of powers are respected, we focused on nations with well-established democratic systems.

The study period from 1997 to 2020 was chosen to provide an understanding of the relationship between female representation in parliament and environmental sustainability over time. However, the timeframe was also shaped by the availability of data on the key variables. The dependent variable in our analysis is environmental sustainability, which we measure through green growth indicators because they provide a holistic view of environmental outcomes. Our variable of interest is the representation of women in parliament, reflecting the role of female leadership in shaping national policies and priorities.

We collected the data for this study from reputable sources, including the World Development Indicators and OECD statistics. These databases offer reliable and consistent data on both environmental indicators and parliamentary representation, ensuring the robustness of our econometric analysis. By focusing on these well-established data sources, we aimed to provide accurate and meaningful insights into the intersection of gender representation and environmental policy in democratic contexts.

3.2. Definition and measurement of variables

Environmental sustainability: Unlike prior studies, which measure sustainability through carbon emissions (Ergas and York, 2012; Lv et al., 2022; Mavisakalyan and Tarverdi, 2019), we used recent indicators that capture policies and strategies on environmental sustainability. We used green growth from the OECD to measure the environmental sustainability of the country. Green growth incorporates the effectiveness of policies and strategies implemented by the government to address climate change and environmental sustainability (OECD, 2020). We argue that parliamentarians have more control over policies and strategies that affect environmental sustainability than the amount of carbon emissions. This variable has been used in other studies (Tawiah et al., 2021, 2023). The higher the value, the greener the country's economic growth. Data were sourced from OECD statistics.

3.2.1. Female parliamentarians

Consistent with prior studies (Ergas and York, 2012; Lv et al., 2022; Mavisakalyan and Tarverdi, 2019), we measured female parliamentarians as the proportion of seats held by women in national parliaments. Data were sourced from World Development Indicators.

3.2.2. Control variables

In line with prior studies (Amin et al., 2020; Khan et al., 2022;

Paramati et al., 2021; Shaheen et al., 2020), we controlled for other factors likely to influence environmental sustainability. These include carbon emissions, a proxy for environmental pollution, reflecting the level of CO₂ emissions per capita, which indicates environmental degradation. Trade openness, measured as the sum of exports and imports as a percentage of GDP, captures a country's integration into the global economy and its potential impact on resource consumption and pollution. Population size and growth rate are included to account for the pressures that population dynamics place on natural resources and waste management. Research and development (R&D), measured as a percentage of GDP, represents a country's investment in innovation and sustainable practices, highlighting the role of technological advancements in addressing environmental challenges. Finally, reserved seats for women in parliament measures a country's commitment to promoting female leadership, which can influence environmental policy. These control variables help ensure that the specific impact of female parliamentarians on environmental sustainability is accurately assessed.

3.3. Model specification

This study investigates the role of female parliamentarians in environmental sustainability conditioned on the cultural orientation of the country. The baseline model is constructed as follows:

$$SUS_{it} = \beta_0 + \beta_1 FP_{it-1} + \beta_2 X_{it-1} + \alpha_{it} + \delta_{it} + \varepsilon_{it} \quad (1)$$

where SUS represents environmental sustainability; FP refers to a female parliamentarian; X is the vector of control variables, which comprises carbon emissions, trade openness, population and research and development; α is an individual country factor, δ is a time-specific factor; ε refers to the error terms; and i and t represent countries and time, respectively.

$$SUS_{it} = \beta_0 + \beta_1 FP_{it-1} + \beta_1 CL_{it-1} + \beta_1 FP*CL_{it-1} + \beta_2 X_{it-1} + \alpha_{it} + \delta_{it} + \varepsilon_{it} \quad (2)$$

where CL is the vector of cultural indicators, which comprises power distance, masculinity, uncertainty avoidance, individualism, long-term orientation, and indulgence; FP*CL is female parliamentarian and culture, which stands for the moderating effect of cultural dimension on female participation and its ultimate impact on environmental sustainability. All other variables remain the same as explained in eq. (1).

To estimate our model, we considered the fixed effects model, which helps account for unobserved factors that vary across countries but remain constant over time, consistent with the findings of Nchofoung and Asongu (2022); Shobande and Ogbeifun (2022). Notable limitations of the fixed effects model include the assumption that the fixed effects are uncorrelated with the independent variables and the potential omission of relevant time-varying factors, which may potentially cause endogeneity problems. Ignoring endogeneity can result in biased coefficient estimates and deceptive statistical inference (Antonakis et al., 2014; Echambadi et al., 2006). The literature (Lin and Liscow, 2013; Lin and Liu, 2009) has recommended using instrumental variables (IV) estimation to mitigate endogeneity concerns in the fixed effects model. Following (Bronars and Oettinger, 2006; Wen and Maani, 2022), we employed instrumental variable two-stage least square estimation (IV-2SLS). By utilizing these instruments, this technique addressed endogeneity. IV-2SLS use IV that are correlated with the endogenous regressors but uncorrelated with the error term (Angrist and Krueger, 2001).

How this work is that, in the first stage, the endogenous variable is regressed on the instruments to obtain predicted values, which are then used in the second stage regression to consistently estimate the causal effect on the dependent variable. The validity of IV estimates hinges on the strength and exogeneity of the instruments, often assessed through tests like the first-stage F-statistic.

We also considered the S-GMM as a robustness to the findings of IV-

2SLS. S-GMM also to address endogeneity issues arising from omitted variables, measurement errors, and simultaneity bias in dynamic panel data models (Arellano and Bover, 1995). This estimator improves upon the difference-GMM approach by incorporating additional moment conditions that enhance efficiency, especially when the autoregressive parameter is close to unity or when the instruments in difference-GMM are weak (Roodman, 2009). S-GMM is particularly advantageous in studies where explanatory variables are endogenous because it employs internal instruments derived from lagged values of the variables, reducing the risk of instrument proliferation and weak identification (Khatib, 2024).

Moreover, S-GMM accommodates unobserved heterogeneity by controlling for time-invariant fixed effects while addressing potential biases in short panel settings. For additional robustness testing, we selected an alternative IV method—instrumental variable generalised moment method (IV-GMM)—and incorporated both the country and time effects into the model. This is an effective model for addressing endogeneity and obtaining accurate and consistent estimates of causal relationships in regression analysis (Muhammad et al., 2022).

4. Results and discussion

4.1. Preliminary analysis

Table 2 presents descriptive statistics, the results indicating that the average mean of environmental sustainability is 1.192, with a standard deviation of 1.644, indicating variation among the selected countries. Female parliamentarians stood at an average of 11.687 women per annum. Table 3 displays the pairwise correlations, and the results indicate a correlation between dependent variables and independent variables at a threshold of <8 points, indicating that our model does not have a multicollinearity issue. (See Table 1.)

4.2. Cross-sectional dependence and unit-root test

In this study, we used panel data wherever there were multiple countries at a single point in time. As cross-sectional dependence can arise in this dataset from various factors, such as spatial spillovers, common shocks, or unobserved heterogeneity across countries, we tested for cross-sectional dependence. The results (see Table 4) confirm that all the variables (i.e., environmental sustainability, female parliamentarian, carbon emissions, trade openness, population, environmental stridency, and R&D) are cross-sectionally dependent; hence, the need to estimate for unit-root tests that account for cross-sections. For this, we used the cross-sectional augmented Dickey-Fuller (CADF) unit-root test. The results in Table 4 (columns 3 and 4) show that only environmental sustainability, trade openness, and R&D are stationary at this level. However, we find that all the variables (i.e., environmental

sustainability, female parliamentarian, carbon emissions, trade openness, population, environmental stridency, and R&D) are stationary at first difference.

4.3. Baseline results

When using panel data, uncommon factors across the dataset must be considered, given the heterogenous nature of countries. Prior studies (Aldieri et al., 2019; Hedges, 1994; Kendo and Tchakounte, 2022) have documented that the fixed effects model is most appropriate to account for unobserved heterogeneity (Aldieri et al., 2019; Hedges, 1994; Kendo and Tchakounte, 2022). Therefore, we used a fixed effects model (see column 1 of Table 5 for results). The coefficient of female parliamentarians (0.018***) is positive and statistically significant at a 1 % level, suggesting that female parliamentarians contribute significantly to environmental sustainability. This is partly consistent with Ergas and York (2012), Lv et al. (2022), and Mavisakalyan and Tarverdi (2019), who found that female parliamentarians are more likely to support environmental sustainability legislation and actions.

The fixed effects model is weak in addressing endogeneity issues. Therefore, the literature (Cooper et al., 2020; Ullah et al., 2021; Zahid et al., 2020) has suggested using instrumental variables to address endogeneity. We follow Kruse et al. (2022), who use a 2SLS model to address endogeneity, and the results are reported in Table 5 (columns 2 & 3). We use three instrumental variables—namely, quota seats, electoral system, and religion—which is consistent with Perdana and Hillman (2020); Prihatini (2019); Rule (2019), who use quota seats, the electoral system, and religion as determinants of women's representation in parliament. Column 2 shows the first-stage regression, and the findings show that the coefficient of quota seats, the electoral system, and religion capture female parliamentarian relations, which best satisfies the exclusion restrictions.

On the one hand, we found that quota seats for women are positive, suggesting that quota seats are associated with increasing female representation in parliament. Quota seats for women, whether through legislative measures or political party rules, help increase the number of women elected to the legislative chamber, which is partly consistent with Dahlerup and Freidenvall (2005), who found that quota seats have helped fast-track female representation in Scandinavian countries. Similarly, we found that the electoral system plays a significant role in promoting female representation in parliament, which is not surprising given electoral systems such as proportional representation tend to impact positively on female representation, allocating seats in proportion to the votes received by political parties or candidates, usually through party lists. This is partly consistent with Caul (1999), who found that the electoral system promotes female representation. Also, we found that religion discouraged female participation in parliament, which is partly consistent with Hillman (2017), who found that religious leaders discouraged female participation in politics. In addition, the quota seats, the electoral system, and religion are uncorrelated with environmental sustainability, indicating that our instrument satisfied the exogeneity assumption. In all panels, the coefficient of F-statistics is >10, indicating that our IV is well-fitted and reliable.

Column 3 of Table 5 shows that the coefficient of female parliamentarians (0.028***) is positive and statistically significant at a 1 % level, suggesting female parliamentarians contribute to environmental sustainability. Female participation in parliament ensures better representation and inclusion of diverse perspectives related to environmental sustainability. Women often have different lived experiences and concerns regarding the environment than men, such as the impact of environmental degradation on their health, livelihoods, and the well-being of their communities. By bringing these perspectives to decision-making, women can help shape policies and actions that address these unique environmental challenges.

Women in parliament often excel at building coalitions and fostering collaboration across party lines, a unique attribute that boosts their

Table 2
Descriptive Statistics.

Variable	Mean	Std. Dev.	Min	Max
SUS	1.192	1.644	-4.97	8.6
FP	11.687	16.56	0	102
CO2	8.943	4.29	1.347	20.47
TRO	72.574	43.19	0	227.738
POP	56,092,403	66,415,147	1,981,629	3.268e+08
RD	1.026886	1.039452	0	3.58418
RSS	0.887	0.317	0	1
ES	2.459	2.047	0	7
RG	0.944	0.231	0	1
PD	51.018	18.028	11	81
MUS	57.339	19.374	14	95
UNA	70.082	20.153	35	94
IND	63.29	21.969	13	91
LTO	49.537	21.564	13	88
INDUL	58.979	17.155	29	97

Table 3

Pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) SUS	1.000														
(2) FP	0.244	1.000													
(3) CO2	0.151	0.083	1.000												
(4) TRO	0.019	0.125	-0.066	1.000											
(5) POP	-0.031	0.021	0.348	-0.521	1.000										
(6) RD	0.106	0.107	0.277	0.067	0.175	1.000									
(7) RSS	0.058	-0.155	-0.065	-0.081	-0.068	-0.231	1.000								
(8) ES	0.037	0.283	-0.102	0.078	-0.031	-0.078	0.342	1.000							
(9) RG	0.050	-0.204	-0.017	0.269	-0.260	-0.254	0.686	0.294	1.000						
(1) PD	-0.047	-0.021	-0.405	-0.218	0.105	-0.116	-0.168	0.073	-0.040	1.000					
(11) MUS	-0.005	0.233	-0.048	-0.298	0.252	0.002	-0.316	0.068	-0.476	-0.253	1.000				
(12) UNA	-0.098	-0.111	-0.463	-0.168	-0.067	0.009	-0.406	-0.191	-0.266	0.752	-0.053	1.000			
(13) IND	0.064	-0.031	0.691	0.100	0.161	0.179	0.045	0.196	0.193	-0.522	-0.043	-0.580	1.000		
(14) LTO	-0.120	-0.147	-0.106	0.186	-0.152	0.277	-0.587	-0.197	-0.437	-0.040	-0.014	0.352	0.181	1.000	
(15) INDUL	-0.015	0.165	-0.009	0.049	0.078	-0.152	0.197	-0.005	0.242	-0.134	0.056	-0.450	-0.141	-0.491	1.000

Table 4

Cross-sectional dependence and unit-root tests.

Pesaran CSD test		CADF unit-root test	
		Level	1st difference
Variables	CD	Z[t-bar]	Z[t-bar]
SUS	26.244***	-2.747***	-7.783***
FP	12.713***	1.819	-2.491**
CO2	4.783***	-0.096	-4.442***
TRO	19.369***	-2.448**	-3.390***
POP	2.832**	5.673	-2.516**
RD	40.698***	-3.371***	-10.534**

Standard errors in parentheses.

*** p < 0.01.

** p < 0.05.

* p < 0.1.

Table 5Fixed effect & 2SLS-IV results (Dep Var: Δ SUS, Δ FP).

Variable	Fixed effect	2SLS	
	Δ SUS	Δ WUP _{t-1}	Δ SUS
Δ FP _{t-1}	0.018*** (0.007)		0.028*** (0.006)
Δ InCO2 _{t-1}	0.364*** (0.088)	-0.956 (0.718)	0.049*** (0.019)
Δ TRO _{t-1}	-0.017*** (0.004)	-0.116*** (0.037)	-0.001 (0.002)
Δ POP _{t-1}	-0.002 (0.001)	-0.003*** (0.009)	-0.004*** (0.002)
Δ RD _{t-1}	0.107 (0.084)	0.756 (0.947)	0.145** (0.072)
Δ RSS _{t-1}		93.12** (42.91)	
Δ ES _{t-1}		-56.78** (25.55)	
Constant	-0.195 (1.230)	66.65*** (14.80)	136.5*** (19.99)
Fixed country effect		Yes	Yes
Fixed year effect		Yes	Yes
F-statistics		54.52	17.28
Observations	493	493	493

Standard errors in parentheses.

*** p < 0.01.

** p < 0.05.

* p < 0.1.

ability to work with environmental organizations, civil society groups, and other stakeholders to advance environmental sustainability. In forging partnerships and alliances, women can amplify their advocacy efforts, raise awareness, and build consensus on environmental issues.

Table 6

S-GMM results (Dep Var: SUS, EEF).

Variables	(1)	(2)	(3)
	Δ EEF	Δ SUS	Δ SUS
Δ FP _{t-1}	0.005* (0.003)		-0.291*** (0.048)
Δ EEF _{t-1}	-0.137 (0.125)	5.818*** (1.451)	-3.357*** (0.887)
Δ EEF _{t-2}	-0.076 (0.050)		
Δ EEF _{t-3}	0.314** (0.159)		
Δ FP _{t-1} * Δ EEF _{t-1}			0.298*** (0.044)
Δ SUS _{t-1}	-0.605*** (0.081)	-0.388*** (0.084)	-0.054 (0.056)
Δ SUS _{t-2}	-0.844*** (0.068)	-0.151 (0.155)	
Δ InCO2 _{t-1}	0.0714 (0.076)	0.238 (0.287)	0.223* (0.126)
Δ TRO _{t-1}	-0.013** (0.005)	0.043* (0.023)	-0.007 (0.009)
Δ POP _{t-1}	-0.0018** (0.001)	0.001 (0.002)	-0.003*** (0.009)
Δ RD _{t-1}	0.745*** (0.141)	0.020 (0.226)	-0.498** (0.203)
Fixed country effect	YES	YES	YES
Fixed year effect	YES	YES	YES
Constant	-279.3*** (46.57)	2326*** (494.5)	27.21 (73.74)
AR(1)	(0.175)	(0.142)	(0.005)
AR(2)	(0.230)	(0.457)	(0.110)
Hansen test	(0.185)	(0.106)	(0.116)
Instruments	15	12	17
Observations	472	426	426
Number of ID	18	18	18

Standard errors in parentheses.

*** p < 0.01.

** p < 0.05.

* p < 0.1.

Collaboration is crucial for creating long-lasting change and implementing sustainable practices. Regarding control variables, our findings are consistent with our expectations. For instance, we found that carbon emissions, trade openness, and population are associated with worsening environmental sustainability, while R&D is associated with improving environmental sustainability.

4.4. Channels analysis

To further illustrate the relationship between female parliamentarians and environmental sustainability, we conducted a channel analysis

Table 7Ordinary Least Square (OLS) results (Dep Var: Δ SUS).

Variables	(1) Δ SUS	(2) Δ SUS	(3) Δ SUS	(4) Δ SUS	(5) Δ SUS	(6) Δ SUS
Δ PD _{t-1}	0.004 (0.004)					
Δ FP _{t-1} * Δ PD _{t-1}	-0.002* (0.010)					
Δ MUS _{t-1}		0.002 (0.004)				
Δ FP _{t-1} * Δ MUS _{t-1}		-0.001** (0.003)				
Δ UNA _{t-1}			0.005 (0.04)			
Δ FP _{t-1} * Δ UNA _{t-1}			-0.001*** (0.001)			
Δ IND _{t-1}				-0.004 (0.004)		
Δ FP _{t-1} * Δ IND _{t-1}				0.001** (0.002)		
Δ LTO _{t-1}					-0.008* (0.004)	
Δ FP _{t-1} * Δ LTO _{t-1}					0.001** (0.002)	
Δ INDUL _{t-1}						-0.002 (0.004)
Δ FP _{t-1} * Δ INDUL _{t-1}						-0.001 (0.002)
Δ FP _{t-1}	0.015*** (0.005)	0.0174 (0.017)	0.0392*** (0.00934)	-0.0240* (0.0133)	0.00731 (0.00848)	0.0150 (0.0152)
Δ SUS _{t-1}	0.315*** (0.045)	0.322*** (0.044)	0.286*** (0.045)	0.302*** (0.045)	0.308*** (0.044)	0.318*** (0.045)
Δ InCO2 _{t-1}	0.030* (0.016)	0.027* (0.015)	0.020 (0.016)	0.014 (0.020)	0.019 (0.015)	0.028* (0.015)
Δ TRO _{t-1}	0.001 (0.002)	0.001 (0.002)	-0.005 (0.002)	0.001 (0.002)	0.002 (0.002)	0.001 (0.002)
Δ POP _{t-1}	-0.007 (0.001)	-0.006 (0.001)	-0.001 (0.001)	0.002 (0.001)	-0.009 (0.001)	-0.004 (0.001)
Δ RD _{t-1}	0.027 (0.082)	-0.006 (0.080)	0.073 (0.083)	-0.001 (0.079)	0.123 (0.096)	-0.042 (0.088)
Constant	-0.199 (0.403)	0.016 (0.396)	-0.143 (0.458)	0.385 (0.363)	0.502 (0.381)	0.123 (0.375)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	493	493	493	493	493	493
R-squared	0.531	0.528	0.541	0.535	0.536	0.529

Standard errors in parentheses.

*** p < 0.01.

** p < 0.05.

* p < 0.1.

that examined the impact of female parliamentarians on the stringency of environmental regulations. The results are reported in [Table 6](#).

We employed a three-stage modelling approach to establish this relationship. In stage 1 (i.e., column 1), we estimated the relationship between the proportion of female parliamentarians and the stringency of environmental regulations. The result reveals that the coefficient of female parliamentarians (0.005*) is positive and significant at 10 %, indicating that a higher representation of women in parliament drives stricter environmental regulations. In stage 2, we assessed the relationship between the stringency of environmental regulations and environmental sustainability (column 2). As expected, the coefficient of environmental stringency (5.818***) is positive and significant at 1 %, showing that stricter regulations lead to improved sustainability outcomes. In stage 3 (column 3), we conducted a moderating analysis to examine how the interaction between female parliamentarians and stringent environmental regulations influences environmental sustainability. The findings highlight that the coefficient of the moderating term (woman parliamentarian*environmental stringency) (0.298***) is positive and significant at 1 %, suggesting female parliamentarians through environmental stringency significantly enhance sustainability outcomes.

These analyses collectively demonstrate that female

parliamentarians are positively and significantly associated with environmental sustainability, primarily through their role in advocating for and driving stricter environmental regulations. The channel analysis provides robust evidence of the mechanisms linking gender representation in parliament to sustainability outcomes. These findings are partly consistent with femininity culture which emphasis of care and quality of life. From a practical standpoint, the results show the importance of allowing female to vy for political position in considerations into sustainability decisions. Policymakers can leverage this evidence to prioritize projects that not only address immediate environmental needs but also enhance long-term economic inclusiveness, particularly for sectors such as small business and tourism that are sensitive to infrastructure disruptions.

4.5. Accounting for cultural heterogeneity

Cultural norms and stereotypes surrounding gender roles can influence the ability of women to advocate for environmental sustainability in parliament. In some cultures, women may face social expectations limiting their participation in public and political spheres, including environmental issues. Given this fact, we account for cultural heterogeneity. The results are presented in [Table 7](#). Meanwhile, endogeneity is

Table 8
Robust check –IV-GMM results (Dep Var: Δ SUS, Δ FP,)

Variables	(1) Δ WUP	(2) Δ SUS
Δ FP _{t-1}		0.034**** (0.005)
Δ InCO2 _{t-1}	-0.337* (0.198)	0.062*** (0.014)
Δ TRO _{t-1}	0.132*** (0.023)	-0.001 (0.002)
Δ POP _{t-1}	0.008*** (0.002)	-0.003*** (0.001)
Δ RD _{t-1}	1.161 (0.771)	0.118*** (0.041)
Δ RSS _{t-1}	-1.499 (2.439)	
Constant	987.7*** (205.0)	134.7*** (12.53)
Fixed country effect	Yes	Yes
Fixed year effect	Yes	Yes
F-statistics	10.40	
Observations	493	493

Robust standard errors in parentheses.

*** p < 0.01.

** p < 0.05.

* p < 0.1.

Table 1
Variables measurement and sources.

Variable	Measurement	Sources
Environmental sustainability (SUS)	The index comprises, environmental and resource productivity, natural resources assets base, environmental dimension of quality of life, and economic opportunities and policy response	OECD statistics (2023)
Female parliamentarian (FP)	The number of women in the upper legislative chamber	
Carbon emissions (CO2)	Carbon dioxide emission metric per capita	WDI (2023)
Trade openness (TRO)	The sum of exports and imports as a percentage of GDP	WDI (2023)
Population (POP)	The total population comprises males, females, adults, and children	WDI (2023)
Research and development (RD)	Research and development expenditure as a percentage of GDP	WDI (2023)
Reserve seats (RSS)	The number of seats reserved for women in the constitution or by political parties	International IDEA Institute for Democracy and Electoral Assistance (2023)
Electoral system (ES)	The electoral system operated by a country	International IDEA Institute for Democracy and electoral assistance (2023)
Religion (RG)	The dominant religion of a country	WDI (2023)
Environmental stringency (EEF)	Environmental-related taxes of a country	OECD statistics (2023)
Power distance (PD)	Measure cultural index	Hofstede insight (2023)
Masculinity (MUS)	Measure cultural index	Hofstede insight (2023)
Uncertainty avoidance (UNA)	Measure cultural index	Hofstede insight (2023)
Individualism (IND)	Measure cultural index	Hofstede insight (2023)
Long term orientation (LTO)	Measure cultural index	Hofstede insight (2023)
Indulgence (INDUL)	Measure cultural index	Hofstede insight (2023)

commonly found in panel datasets or models, which can lead to biased and inconsistent parameter estimates. Endogeneity arises when a correlation occurs between the independent variables and the error term in a regression model. Therefore, by including a lagged dependent variable as an explanatory variable, we are essentially using the past values of the dependent variable to help explain the current values of the independent variable. This can help capture some of the omitted variables or unobserved factors driving the endogeneity. For this reason, we included the lag of environmental sustainability to control for endogeneity.

Table 7 shows that power distance and the moderating term (female parliamentarian*power distance) reduce environmental sustainability, suggesting that power distance could influence the negative relationship between female parliamentarians and environmental sustainability. This is expected in high power distance societies that may uphold traditional gender norms and stereotypes that assign women to certain roles, often excluding them from active participation in politics and policymaking. The exclusion could hinder the ability of female parliamentarians to champion environmental sustainability initiatives. In addition, societies with a high power distance may have strong hierarchical structures that limit the influence and participation of women in decision-making processes, including environmental policy. Female parliamentarians in such societies might find it hard to advocate for environmental sustainability measures, as their voices may be marginalized or ignored. This is partly consistent with Lee et al. (2022), who found a reverse relationship between societies with power distance norms and environmental sustainability.

The coefficient of female parliamentarian*masculinity culture is negative, suggesting that masculinity culture limits female representations and decision-making regarding environmental sustainability. Masculinity culture reinforces gender stereotypes and biases, leading to preconceived notions about the roles and capabilities of women in politics. Female parliamentarians advocating for environmental sustainability may face stereotypes that portray them as less knowledgeable or less capable in economic and environmental matters. These biases can undermine their impact and hinder the recognition of their expertise and contribution to shaping sustainable policies. This finding is partly inconsistent with Lee et al. (2022), who found a positive relationship between masculinity culture and sustainability.

Regarding uncertainty avoidance, a society with a high uncertainty avoidance culture is less open to ambiguity, change, and risk. It is less willing to experiment with new policies and adapt to changing environmental challenges as well as adaptive policies, providing a less conducive environment for women to drive green growth. This is consistent with our finding using the moderating term (female parliamentarian*uncertainty avoidance culture), which negatively affects environmental sustainability. Countries at the high end of uncertainty avoidance orientation are more likely to resist female participation in environmental issues since it will be contrasted to the status quo, high uncertainty avoidance culture, which can be restrictive and slow in providing women with greater opportunities to influence environmental sustainability.

However, a society with a higher individualistic culture can positively influence women in parliament to project their agenda towards environmental sustainability, as shown by the moderating term (female parliamentarian*individual culture). As individualistic cultures tend to emphasize personal freedom, autonomy, and individual agency, they can create an environment where women in parliament are more empowered to act on issues related to environmental sustainability. Such societies may encourage women to pursue their own goals and initiatives, including advocating for environmentally friendly policies and sustainable development. These findings are partly consistent with Muttakin et al. (2022), who found a relationship between the moderating role of democracy on individualist culture and carbon emissions.

The coefficient of the moderating term (female parliamentarian*long-term orientation culture) is positive, suggesting that a long-term orientation culture has a positive influence on female

parliamentarians' impact on environmental sustainability. This is expected, given that societies with a high long-term orientation are more likely to prioritize sustainable development goals, including environmental preservation and green growth. In such cultures, there may be a greater appreciation for the long-term benefits of environmentally friendly policies and practices. Female parliamentarians advocating for green growth initiatives may find more support and alignment with the societal values and goals in these contexts. This is partly consistent with Long et al. (2023), who found that a long-term cultural perspective improved environmental performance. On the control variables, the findings are consistent with our expectations—for instance, carbon emissions, trade openness, and population have a detrimental influence on environmental sustainability, while R&D is associated with improving environmental sustainability.

This study provides a novel theoretical contribution by integrating cultural dimensions into the analysis of gender representation in environmental policymaking. Existing literature often treats female political representation as a uniform construct; however, our findings highlight the importance of contextual heterogeneity—particularly cultural norms and values—in shaping the efficacy of female parliamentarians' environmental advocacy. The significant interactions between cultural variables (e.g., power distance, masculinity, uncertainty avoidance, and individualism) and female political representation expand our understanding of how sociocultural environments either constrain or enable sustainable governance. Practically, this suggests that promoting gender inclusion in environmental policy cannot rely solely on increasing the number of women in parliament. Instead, it requires tailored strategies that account for cultural attitudes towards gender roles and political participation. For instance, interventions in high power-distance societies may need to focus on institutional reforms and norm-shifting campaigns to elevate women's political agency in environmental discourse.

4.6. Robustness check with IV-GMM

To further validate our results, we conducted a robustness check using IV-GMM, and the results are presented in Table 8. The first-stage regression in column 2 satisfied the exclusion criterion. Further, the coefficient of F-statistics in all panels is above 10, suggesting our instruments are not correlated with the dependent variables. The second-stage regression is represented by the model in column 1. The results confirm that the coefficient of female parliamentarians is positive and significant, suggesting that women's participation in the legislative chamber is associated with improving environmental sustainability, which is not quantitatively different from the main results presented in Table 5. Therefore, we conclude that the findings are robust to the alternative IV approach and well-fitted.

5. Conclusion and policy implications

It is vital to acknowledge the diverse cultural contexts that shape the intricate relationship between culture, women's political participation, and environmental legislation. Understanding and engaging with these cultural dimensions is essential for crafting inclusive and effective policies that promote environmental sustainability and gender equality. This study has examined the impact of female parliamentarians on environmental sustainability, incorporating cultural dimensions as moderating factors. To achieve this, we applied the 2SLS and S-GMM models to address endogeneity concerns and validated our findings using an alternative IV approach (IV-GMM).

Our findings indicate that the participation of women in legislative chambers significantly contributes to improving environmental sustainability. Women bring unique perspectives and experiences to decision-making processes, particularly in addressing environmental challenges. Their involvement ensures a broader understanding of sustainability issues, fostering innovative solutions and inclusive policies

that address a wider range of environmental concerns. The analysis also reveals heterogeneity in cultural norms and their influence on the relationship between women's political participation and environmental sustainability. Specifically, cultural dimensions such as power distance, masculinity, and uncertainty avoidance are found to limit the positive impact of female parliamentarians. These cultural orientations are often dominated by male perceptions and stereotyping attitudes that emphasize dominance, hierarchical structures, and material pursuits and hinder the contributions of women to policymaking. Conversely, long-term orientation and individualism are cultural dimensions that amplify the positive influence of female parliamentarians on environmental sustainability.

Societies characterized by individualism and long-term orientation are more open to change, adaptability, personal freedom, and risk-taking. These traits empower women and amplify their voices, facilitating the acceptance of new ideas, technologies, and approaches to address environmental challenges. The positive interplay between these cultural dimensions and women's participation in legislative processes supports the development of forward-looking and innovative policies for sustainability.

The findings of this study have significant policy implications, particularly in fostering a more inclusive and sustainable approach to environmental governance. One essential recommendation is to develop targeted communication campaigns that align sustainable behaviours with values commonly associated with individualistic cultures, such as personal freedom, autonomy, and self-expression. These campaigns should emphasize the collective impact of individual actions on the environment, helping to connect personal values with broader sustainability goals. In addition to communication strategies, initiatives that publicly recognize and reward individuals who consistently engage in environmentally friendly practices should be established. Such programs could appeal to the desire for social recognition and status, which are particularly influential in individualistic societies. By showcasing these practices as socially desirable, governments and organizations can encourage the widespread adoption of sustainable behaviours. Investments in long-term sustainable infrastructure are also crucial. Resources should be allocated to projects such as renewable energy systems, public transportation networks, and efficient waste management facilities. These investments not only address pressing environmental challenges but also create a foundation for sustained progress towards sustainability goals. Stable and predictable regulatory frameworks must complement these efforts, incentivizing long-term sustainable practices and investments. Policy fluctuations should be avoided because they can discourage stakeholders from making the necessary long-term commitments.

While these policy recommendations offer a pathway to leverage cultural dimensions for greater environmental sustainability, the study has limitations. Cross-country analyses, while valuable, may obscure nuances within individual countries. Cultural, political, and economic factors often interact differently in specific national contexts, and these variations are not necessarily captured in a broad comparative approach.

Future research could address these limitations by incorporating case studies of individual countries. Such studies would enable a more in-depth examination of the interplay between gender representation, cultural norms, and environmental policy in distinct settings. This approach could provide richer contextual insights and uncover mechanisms overlooked by broader cross-country analyses, ultimately advancing our understanding of how to foster environmental sustainability in diverse cultural and political landscapes.

CRedit authorship contribution statement

Tuhuo Jia: Software, Conceptualization. **Vincent Tawiah:** Writing – original draft, Data curation. **Abdulrasheed Zakari:** Writing – review & editing, Visualization, Methodology, Investigation. **Francis Osei-**

Tutu: Writing – review & editing, Validation, Supervision.

Data availability

No data was used for the research described in the article.

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