ASPROWORDA

Working Paper 13/2023

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Forthcoming: Politics & Policy

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Abstract

Motivated by the difficulty of ensuring gender equality and the chaotic state of democracy, we analyze the effects of gender political inclusion and democracy on environmental policy performance. The study uses a panel of 45 African countries over the period 2012-2018 and employs the method of moments by quantile regression. The results show that, gender political inclusion and democracy positively affect environmental performance in all quantiles. These positive effects tend to be stronger at higher quantiles. The magnitude is larger for gender political inclusion. When performance is decomposed into the sub-indices of environmental health and ecosystem vitality, positive effects of gender political inclusion and democracy are observed in all quantiles. The effects are larger for the gender dimension than for the democracy dimension, regardless of the sub-index used.

***Keywords*:** Gender political inclusion; democracy; environmental performance; regression quantile method of moments; Africa.

***JEL Classification* :** J13 ; Q56 ; C31 ; C33

1 The views expressed in this working paper are those of the authors and do not necessarily represent those of the ASPROWORDA, its Executive Board, or its management.

1. Introduction

This paper seeks to understand the roles of political inclusion of gender and democracy on environmental performance. While environmental performance is a measure for assessing progress towards environmental policy goals at the national level (Wendling et *al.*, 2020), it is considered a priority in socio-economic and political developments worldwide (OECD, 2001). For example, international institutions have included the goal of ecological transition in their agendas (UN, 2022). Most countries have developed climate action plans to reduce and adapt to climate impacts through nationally determined contributions (NDCs) (UN, 2022). However, commitments at the national level are not sufficient to achieve the 1.5°C objective, as global greenhouse gas emissions are projected to increase by almost 14% over the next decade at current levels of commitment (UN, 2022).

Despite these difficulties in ensuring environmental sustainability, much work has been done to understand the factors that determine environmental sustainability. Early work linked environmental protection to economic development (Stern et al., 1996; Cole et al., 1997; Arrow et al., 1995; Selden and Song, 1994; Grossman and Krueger 1996; Grossman and Krueger, 1993, 1995; Shafik, 1994). According to the Kuznets environmental curve, the level of pollution increases in the early stages of development and decreases in the later stages. Environmental protection is also linked to adopting and using new information and communication technologies (AñónHigón, 2017; Elliot, 2011; Melville, 2010; Watson et al, 2012; Gholami et *al.*, 2013). Information and communication technologies play a triple role in environmental protection: (i) the construction of smart cities with the adoption of renewable energy (Batool et al., 2022); (ii) the adoption of less polluting transport systems; and (iii) the implementation of more responsible industrial processes. The ecological transition also depends on the control of urbanization (Abbasi et al., 2021; Mignamissi and Djeufack, 2021; Shahbaz et al., 2016; Parikh and Shukla, 1995; Poumanyvong, 2010) or the degree of trade openness (Ndour and Faye, 2021; Dauda et al., 2020; Essandoh et al., 2020).

Gender mainstreaming and democracy promotion are explanatory factors for environmental protection (Aydin, 2022; Salahodjaev and Jarilkapova, 2020; Hunter et *al.*, 2004; Sturgeon 1997). The effect of women's political empowerment on the environment works in several ways. First, decision-makers that are women are more sensitive to environmental issues (Hunter et al., 2004). Secondly, women's political representation in parliaments improves the quality of governance, which in turn affects environmental protection (Dollar et al., 2001; Ali et al., 2019). Finally, women's political participation promotes economic development, which

influences environmental performance (Jayasuriya and Burke, 2013). Regarding democracy, two aspects can be considered. First, the correct definition of property rights and respect for democratic electoral systems and, how human rights affect the effectiveness of environmental policies (Magnani, 2000). Finally, corruption and rent-seeking behavior set the level of carbon emissions above the socially optimal level (Lopez and Mitra, 2000).

It is also worthwhile to note that democracy is characterized by a plethora of externalities, especially as it pertains to the phenomenon being linked with ethnic and social cleavages that are not desirable, reducing conflicting tensions and promoting security and peace (Armijo and Gervasoni, 2010). According to Acemoglu et al. (2019), economic growth is positively linked to democracy while the phenomenon can increase corruption in poor countries and associated with better governance standards in nations characterized by higher income streams (Jetter et al., 2015)[2]. Relative to autocracies, according to Asongu (2014), time and level hypotheses on the rewards democracy are essential in establishing some externalities of economic development such as access to finance. It has also been documented that, *inter alia*, democracy boosts education and health performance (Kaufman and Segura-Ubiergo, 2001; Stasavage, 2005; Rosenberg, 2018) and effectively moderates the potentially unfavorable effect of information technology on wealth inequality (Njangang et al., 2021).

Considering the underlying few works, this research analyses the effect of gender political inclusion and democracy on environmental performance. We hypothesize that, gender political inclusion and its associated freedoms, and democracy are channels through which countries can ensure environmental performance. However, little attention has been paid in the literature to a possible link between women's political empowerment, democracy, and environmental performance. Existing empirical work on unequal gender inclusion focuses on discrete measures of inclusion: (i) women's economic inclusion, measured by the gender pay gap (Koengkan and Fuinhas, 2021); (ii) women's political inclusion, measured by the proportion of seats held by women in national parliaments (Asongu and Salahodjaev, 2022).

In the light of the above, the present paper contributes to the extant literature on women's political inclusion, democracy and environmental performance in several ways. First, the literature on women's political inclusion has broadly focused on improving entrepreneurial opportunities (Al-Dajani and Marlow, 2013; Goltz et al. 2015), strengthening human capital

[2] It is important to note that the narrative does not rule out the possibility of other results in the extant literature (Kurtz and Schrank, 2007a, 2007b; Kaufmann et al., 2007a, 2007a; Khodaverdian, 2021).

(Hornset and de Soysa, 2021), reducing child mortality (Hossain, 2015), mitigating corruption (Barnes and Beaulieu, 2019; DiRienzo and Das, 2019; Jha and Sarangi, 2018; Ngouhouo and Njoya, 2020) and increasing economic prosperity (Doepke and Tertilt, 2019; Duflo, 2012; Kabeer, 2020), improving favorable macroeconomic outcomes in terms of economic growth and development (Choudhry and Elhorst, 2018; Jemiluyi and Yinusa, 2021), financial inclusion (Balasubramanian and Kuppusamy, 2020) and fiscal performance (Asongu et al., 2021). Second, the difference between our paper and those of others (Koengkan and Fuinhas, 2021; Asongu and Salahodjaev, 2022) lies in the methodology itself. While the authors use the generalized method of moments, we have estimated the parameters of the variables using the quantile regression technique of the generalized method of moments (GMM). This method allows us to identify the effects of political inclusion of gender and democracy on different levels of environmental performance.

Third, while many studies have examined the effects of gender equality on environmental protection, they have largely focused on gender equality from an economic perspective (Koengkan and Fuinhas, 2021). In this sense, we have proxied for gender political inclusion using Principal Component Approach (PCA) in its multiple facets that integrate both women's civil liberties, women's participation in civil society, women's political empowerment, women's participation in the economy and society, and women's political representation in decision-making bodies. This approach enables the articulation of the synergy effect of the different variables on women's political inclusion. The same principle applies to democracy, which combines mandatory referendum, plebiscite, and the top-down component of the direct popular vote. This research follows the UN's Sustainable Development Goals (SDGs), to help policy makers develop more initiatives to promote gender equality and democracy while fostering environmental performance.

There are several reasons for investigating the impact of gender mainstreaming and democracy on the environmental performance of African countries. Despite these existing studies, there is a lack of empirical studies on the relationship between political inclusion, democracy and environmental performance on the African continent. Previous studies have focused mainly on women's economic inclusion (Koengkan and Fuinhas, 2021; Asongu and Salahodjaev, 2015). Therefore, as an extension of the underlying, this study considers women's political inclusion. In addition, the evidence has established that Africa is one of the worst performers in terms of democracy in the world (Nchofoung et al., 2023a). Furthermore, this study distinguishes between the effects of different types of democracy. Globally, the state of democracy, its

citizens' confidence, values, viability and future are more than threatened. For African countries, the situation is even more worrying. The continent has the highest number of countries with weak democracies. In 2021, only 27% of sub-Saharan African countries lived in total democracy, compared to 100% in Europe and 84% in the Americas (International IDEA, 2022). Moreover, the world is struggling to achieve full gender equality (WEF, 2022). In 2022, gender equality was projected to be achieved at only 68.1% and women's political empowerment at 22% (WEF, 2022). At the current rate of progress, it is estimated that it will take 132 years to achieve full parity and 155 years to close the political empowerment gap. This situation is more chaotic in African countries, where the political empowerment of women in sub-Saharan Africa is only 21.0%, in contrast to countries in Europe, North America, Latin America, and the Caribbean, which have closed the gender equality gap by 39.8%, 33.7 %, and 28.7% respectively (WEF, 2022). Second, the state of democracy is alarming (International IDEA, 2022).

The paper is structured as follows. Section 2 describes the methodology and data approach. Section 3 presents the results of the baseline and robustness check models. Section 4 concludes the paper.

2. Theoretical and empirical literature

2.1 Theoretical underpinnings and intuition

The corresponding narratives on the theoretical underpinnings are consistent with the extant literature on female political empowerment (Asongu and Salahodjaev, 2022; Nchofoung *et al*., 2023b).

In the light of the above, the theoretical framework on the linkage between gender inclusion and outcomes of macroeconomic development are in line with Nchofoung *et al*. (2023b) who have investigated the relationship between the level of infrastructural development and the empowerment of women in the political sphere. In accordance with the narrative, the theory of economic modernity maintains that economic development is the result of a plethora of factors, *inter alia*, political inclusion, heightened democracy and social choice. According to the attendant theory, when contemporary practices are adopted by predominantly traditional societies, economic development externalities are very likely to follow. Furthermore,

according to the relevant theory, economic prosperity and associated favorable externalities are also contingent on endogenous or internal factors (Shrum, 2000; Jenkins and Scanlan, 2001).

In accordance with Asongu and Salahodjaev (2022), the internal forces that drive economic prosperity entail, among others, education, market, democratic institutions and political structures. Within the context of this study, this empowerment theory is apparent and engenders, among others, how people engage the manner in which socio-political systems are affected by existing capacities as well as how attendant actions are contemplated and acted upon by them in order for their thinking to materialize (Zimmerman *et al*., 1992; Perkins and Zimmerman, 1995; Scheyvens, 1999). According to Scheyvens (1999), for political empowerment to be exercised, a plethora of factors should be integrated into economic prospects as well as differences in social status and gender variations in political, economic and institutional governance dynamics. Hence, as maintained by Scheyvens (1999), there is an apparent connection between gender inclusion and inclusive as well as sustainable economic development prospects such as environmental sustainability outcomes. The importance of gender inclusion as posited by Scheyvens (1999) is consistent with more contemporary literature on the subject, notably: Duflo (2012) and Asongu and Salahodjaev (2022).

It is relevant to complement the underlying theoretical insights with the intuition motivation the nexuses between democracy, political inclusion and environmental performance as conceived within the remit of the present study. In accordance with the extant literature on the nexus between democracy and gender political inclusion (Asongu et al., 2023a), gender political inclusion and democracy are likely to promote environmental performance essentially because democracy and gender political inclusion are characterized by certain features which have been documented to promote environmental sustainability (Traoré et al., 2023). These features include, *inter alia*, the involvement of women in politico-economic decisions and more representation of women in organs of decisions that influence sustainable development outcomes (Sundström et al., 2017). In essence, in accordance with the arguments of Asongu et al. (2023a), gender political inclusion embodies a procedure by which the rewards of the female gender are enhanced within the remit of their capacity to affect ideas, decisions and implementation measures that are relevant in influencing political and socio-economic outcomes. Such outcomes entail environmental performance.

2.2. Empirical literature

The corresponding empirical literature is discussed in three main strands, especially in the light of a historical perspective in the first strand, insights into the nexus between political inclusion and democracy in the second strand and linkages between gender inclusion, governance and inclusive and sustainable development outcomes in the third strand. These strands are discussed in the same chronology as highlighted.

First, from a historical perspective it is worthwhile to note that in line with Lipset (1959), it is only in the 1950s and 1960s that democracy in the world became an issue for development agencies, constitutional reformers and modernization theory. While we have earlier posited that economic prosperity depends on political structures, democratic institutions, markets and education, it is relevant to balance the narrative by stating that the democracy-development linkage that was first assessed by Lipset (1959), was questioned in subsequent studies (Huntington,1968; Weiner (1987). For instance, Barro (1996) noted that when a plethora of control variables are considered, the nexus between democracy and economic growth is no longer positive.

Regarding the corresponding debates, Przeworski (2000) put forward three main claims, notably: (i) development does not trigger democratic transitions; (ii) the consolidation of democracy is secured by the economic development and (iii) economic growth is not positively affected by democracy. The second claim has been questioned by Acemoglu et al. (2019) while the first and third claims have been questioned by Epstein et al. (2006). Furthermore, the debate on the democracy/governance and economic growth/development nexus is still ongoing not least, because while there is a strand of literature positing for a positive linkage (Mauro, 1995; Kaufmann et al., 2007a, 2007b), another strand of studies questions the positive nexus (Kurtz and Schrank, 2007a, 2007b).

In the second strand is focused on the linkage between gender political inclusion and democracy, several studies have been concerned with this nexus, entailing Nikooghadam et al. (2018) who have conceived the empowerment of women within the prism of education and labour force participation and concluded that empowering women promotes democratic institutions. It is also worth noting that the incidence of democracy on the empowerment of women is apparent through participation in political and electoral processes (Lindberg, 2004). Furthermore, religion can also be a factor, not least, because Rizzo et al. (2007) have shown

that countries that are Islam-dominated countries are associated with less democratic institutions as well as less support for the inclusion of the female gender. By extension, according to the authors, countries that support gender inclusiveness are more likely to support the consolidation of democratic institutions. It is also worthwhile to emphasize that while the advent of democracy preceded the advent of gender inclusiveness, the modernization process boosts cultural heritage which drives the development of democratic institutions as well as more participation of women in public life (Inglehart *et al*., 2003).

In the third strand focusing on some of the empirical literature, there is a substantial body of literature on the nexus between gender inclusion and better governance quality (Hessami and da Fonseca, 2020; Ngouhouo and Njoya, 2020; Asongu and Salahodjaev, 2022; Nchofoung *et al*., 2021, 2023b). According to the narrative, it is posited that the female gender is generally more likely to be involved in risk-taking while at the same less connected to tendencies that mitigate good governance practices such as corruption features. As argued by Asongu et al. (2021), when women are politically-engaged, such comparatively higher engagement can engender higher levels of tax mobilization. In accordance with the extant literature (Ross et al., 2015; Yaya et al., 2020), enhanced food security and better health outcomes are linked to female empowerment. Furthermore, in the light of Nchofoung *et al*. (2021), gender political inclusion is linked to better industrial and economic development prospects as well as enhanced economic freedom. The stance is consistent with Achuo *et al*. (2021) who argue that environmental sustainability is linked to the socio-economic inclusion of women, contingent on economic prosperity and foreign investment dynamics. With respect to Kengdo *et al*. (2020) and Nchofoung *et al*. (2023a), governance is influenced by both industrial development and gender political involvement.

As recently maintained by Asongu and Salahodjaev (2022), the principal argument on the linkage between political outcomes and gender inclusion is apparent because when females are involved in executive organs of power, less political instability is also apparent and hence, positive investment externalities (i.e., foreign and domestic investment prospects) which are obvious avenues for sustainable development prospects, especially in relation to environmental sustainability. As argued by Nchofoung *et al*. (2023a), there is a tendency by the female gender to use more mechanisms of consensus as well as compromise in the conflict resolution. Hence, the involvement of females in political circles can be expected to engender more effective and

sustainable settlement of disputes (Krauss and Kroeber, 2021), which of course can be very worthwhile when environmental protection is at play. Furthermore, the stability of the government is associated with better investment opportunities, due to *inter alia*, more economic trust linked to investment that is necessary for sustainable development outcomes. The underlying narrative is in accordance with the attendant literature which maintains that trust and institutional development are essential in the building of infrastructure that is conducive for sustainable development outcomes (Dassiou and Stern, 2009; El Ioini *et al*., 2021). With respect to Tadadjeu *et al*. (2021), the female gender has more prospects of investing in sustainable and inclusive infrastructure, especially as it relates to social amenities such as the health and education facilities, a position that is broadly confirmed by Chen (2021), especially in the light of expenditure in education. Beyond the attendant empirical and theoretical considerations in this section, the motivational element of how the present exposition departs from the extant literature has been engaged in the introduction of the study.

3. Methodology and data

This section provides an overview of the models used in the paper. Section 2.1 discusses the methodology of the baseline models, while section 2.2 presents the data.

3.1Methodology

In this research, we consider Dynamic Ordinary Least Squares (DOLS), Fixed Effects Ordinary Least Squares (FEOLS) and Fully Modified Ordinary Least Squares (FMOLS) as baseline models. These models are used for three reasons. First, the Driscoll and Kraay standard error approach (FE-D-K S.E)) is robust to forms of cross-sectional dependence and autocorrelation (Pedroni, 2004). Second, the FMOLS model involves individual intercepts and corrects for serial correlation of error processes across panel members (Pedroni, 2004). Third, the DOLS model, which relies on Monte Carlo simulations and the DOLS estimator, is unbiased and increases both lagged and main differences in the series to minimize endogenous feedback (Kao and Chiang, 2001).

This research adopts the panel quantile regression introduced by Koenker and Bassett (1978). This method of quantiles by moments is an alternative to quantile regression (Machado and Silva, 2019). It offers several advantages, including: (i) distinguishing individual effects in panel data models (Koengkan et al., 2020); (ii) not estimating conditional means under exogeneity; (iii) facilitating the precise identification of the structural quantile function; (iv)

providing robust estimation in the presence of cross-sectional and endogenous variables and disclosing information on how the regressor affects the entire conditional distribution (Koengkan and Fuinhas, 2020) and (v) being more accurate when outliers are taken into account as well as in the presence of a random error term that is not normally distributed (Zhu et al. 2018).

In the panel of method moment regression estimates, the conditional quantiles of a dependent variable Y whose distribution is conditional on a vector k of covariates X belongs to location scale variant models. Y is defined by the following form:

$Y_{it} = \alpha_i + \beta X_{it} + (\delta_i + \gamma Z_{it})\mu_{it}$ (1)

Where Y_{it}, X_{it} and W_{it} of a panel of N individuals$i = 1, \ldots\ldots, N$ over T periods with $P\{\delta_i + \gamma Z_{it} > 0\} = 1$. $\alpha, \beta, \theta, \delta et \gamma$ are the unknown parameters to be estimated. $(\alpha_i, \gamma_i), i = 1, \ldots, n$ represent the fixed effects of individual i and Z comprises a vector k of specified components of X. These components represent differentiable transformations with the element l.

$$Zl = Zl\ (X), l = 1, \ldots\ldots, k$$

X_{it} and U_{it} are i.i.d. for any i fixed and through time (t). According to Machado and Silva (2019), U_{it} are orthogonal to X_{it} and normalized to satisfy moment conditions that do not imply strict exogeneity. Referring to equation (2), the conditional quantile $Q_y(\tau \mathrm{X}|_{it})$ of the dependent variable Y is as follows:

$$Q_y(\tau \mathrm{X}|_{it}) = (\alpha_i + \delta_i\, q(\tau)) + X_{it}'\beta + Z_{it}'\gamma q(\tau)$$

Where X_{it}' includes all exogenous variables. $Q_y(\tau \mathrm{X}|_{it})$ includes the quantiles of the distribution of the dependent variable $y_i(EPI)$which is contingent on the location of the explanatory variables X_{it}. The fixed effect of the quantile τ for individual i is defined by the scalar coefficient:

$$\alpha_i(\tau); \alpha_i(\tau) = (\alpha_i + \delta_i q(\tau))$$

Contrary to the standard least squares fixed effects method, the individual effects fail to exhibit an intercept lag. Considering that there are time-invariant parameters, their heterogeneous impacts can be modified through the quantiles of the outcome variable which is $q(\tau)$ is estimated from the following optimization problem:

$$Min_q = \sum_j \sum_t \rho_\tau \left(R_{it} - (\delta_i + Z_{it}^{'}\gamma)q\right)$$

Where $R_{it} = Y_{it} - \left(\alpha_i + X_{it}^{'}\beta\right) et \rho_\tau(A) = (\tau - 1)\mathrm{AI}\{A \leq 0\} + TAI\{A > 0\}$ is the control function.

3.2Data

Dependent variable

Environmental performance is measured by the Environmental Performance Index (EPI), which shows the state of sustainability in the world and ranks countries according to their performance on climate change, environmental health, and ecosystem vitality. In the field of environmental sustainability, many researchers have discussed the close link between environmental sustainability and environmental performance. Environmental performance has become the key to achieving carbon neutrality and environmental sustainability. Therefore, this study considers the environmental performance index as the main indicator of progress in environmental sustainability. Specifically, the EPI is a composite indicator that varies from 0 to 100 (i.e., from the worst to the best performance). For example, a score of 100 corresponds to an internationally perfect sustainability objective. In total, the index calculation incorporates 32 indicators covering two policy objectives (environmental health and ecosystem vitality) and 11 issue categories (biodiversity and habitat, air quality, heavy metals, sanitation and drinking water, waste management, ecosystem services, climate change, fisheries, pollutant emissions, agriculture and water resources). The EPI is a composite indicator that varies from 0 to 100, (i.e., from the worst to the best performance). For example, a score of 100 corresponds to an internationally perfect sustainability objective. In total, the index calculation incorporates 40 indicators covering two policy objectives (ecosystem vitality and environmental health) and 11 issue categories (biodiversity and habitat, air quality, heavy metals, sanitation and drinking water, waste management, ecosystem services, climate change, fisheries, pollutant emissions, agriculture and water resources). The data are sourced from Wolf et al. (2020).

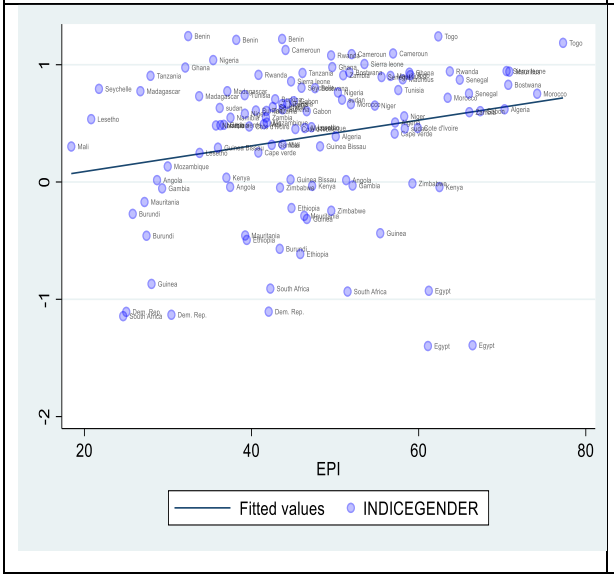
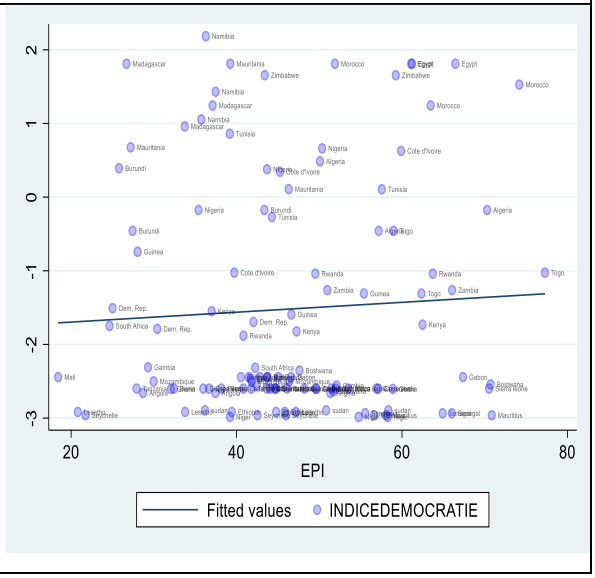
Core Explanatory Variables

Recognizing that no single indicator can adequately capture gender political inclusion or democracy, this study uses principal component analysis (PCA) to construct a gender political inclusion indicator (GINDEX) and a democracy index (DINDEX). Based on the work of Nchogoung et al. (2023a), the system of gender inclusion indicators for Africa is built around freedoms, participation and empowerment: women's civil liberties; women's participation in

civil society; women's political empowerment; and women's political participation. The variables on women's political empowerment are taken from the V-DEM database. Women's political participation is defined as a process of increasing women's capabilities, leading to greater choice, empowerment and participation in decision-making in society. It comprises three equally important dimensions: fundamental civil liberties, women's open debate on political issues and participation in civil society organizations, and women's representation in formal political positions.

To measure democracy, we used the Varieties of Democracy (V-DEM) indicator, which is made up of five indicators of democracy: electoral, liberal, deliberative, participatory and egalitarian dynamics of democracy. The Varieties of Democracy (V-DEM) indicator corrects most of the shortcomings of the measures of democracy used in previous studies, such as the Polity 2 index or the Freedom House measures (Oskarsson and Ottosen, 2010). The main difference between the various measures of democracy is that in electoral democracy, citizens are listened to by leaders through electoral competition and the free functioning of political organizations and civil society. In the liberal principle of democracy, the rights of minority groups are protected against the dual tyranny of the state and the majority. The participatory principle of democracy is based on the active participation of citizens in political processes. The deliberative principle of democracy represents the process by which decisions are taken within the institution. The egalitarian principle of democracy captures the material and immaterial inequalities that prevent the exercise of formal rights and freedoms and reduce the ability of citizens from all social groups to participate. We have drawn on the work of Nchogoung et al. (2023a) to construct the Democracy Index. This democracy index integrates aspects related to mandatory referendum, plebiscite and the top-down component of the direct popular vote (see Appendix Table A2). Figure 1 shows the relationship between the dependent and independent variables of interest in a two-way fitted plot. The figure shows an apparent positive effect of women's political empowerment on democracy.

Figure 1: Two-way fitted plot.

Panel A: EPI and GINDEX	Panel B: EPI and DINDEX
	

Source: Authors' compilation

Control variables

As in existing studies, we introduce control variables to minimize omission bias: these variables include gross domestic product per capita (GDP/capita), urbanization, internet penetration, and foreign direct investment (see tables in the Appendix). All these variables are widely used in the environmental performance literature (Amari et *al.*, 2022; Bekun and Sarkodie 2020; Eregha et *al.*, 2022; Traoré *et al.*, 2023). All the data are sourced from the World Development Indicators (WDI) of the World Bank. The first control variable is GDP per capita (in constant 2010 US dollars). This variable is used in the literature to show the positive effect of the level of development on environmental performance (Ozcan, 2020). The second control variable is the urbanization rate. It is measured by the density of the population living in urban areas (% of total population). The third variable is internet access, measured by the proportion of the population using the internet (% of population). Finally, we captured the effect of foreign direct investment (FDI) using the FDI net inflows variable (% of GDP).

4.Empirical results

In this section, we present some descriptive statistics of the variables and the results of the estimations. The distribution of the variables is analyzed in Section 4.1. The results of the

baselines models within the remits of FMOLS, DOLS, and FEOLS are presented in Section 4.2. Section 4.3 presents the results of the quantile moment panel regression.

4.1. Data Source and Description

As some indicators of environmental performance are largely available after 2012, this study selects panel data from 45 African countries from 2012 to 2018 for the empirical analysis. The number of countries and corresponding periodicity are contingent on data availability at the time of the study. Data for the endogenous variables are collected from Wolf et al. (2022). The indicators of the democracy index are obtained from the Polity V project. All data on control variables are taken from the World Bank's World Development Indicators database. Table 4 presents the definitions and descriptive statistics of the specific indicators.

Table 1 presents the descriptive statistics of the sample from the African continent. The results show that the maximum and minimum values of the EPI are around 18.43 1 and 77.28, respectively. Based on the mean values, the EPI for all countries is about 46.414 and its standard deviation is about 12.614. Furthermore, African countries have an index of gender policy inclusion with a mean of 0.378 and a standard deviation of about 16.723, with a maximum value of 1.244 and a minimum value of -1.398. Finally, based on the mean value of democracy, the results show a mean value of -1.519, which varies from -2.984 to 2.184 with a standard deviation of 1.580.

Table 1: summary statistics of the variables

Variable	Mean	S. D.	Min	Max	Skewness	Kurtosis
EPI	46.414	12.614	18.43	77.28	0.150	2.593
ENH	48.28	16.723	19.7	94.56	0.856	2.886
ECOSV	45.045	13.726	5.82	74.09	-0.204	2.962
GINDEX	0.378	0.627	-1.398	1.244	-1.077	3.467
DINDEX	-1.519	1.580	-2.984	2.184	0.984	2.523
GDP	478856.5	866391.8	4.052	5144727	3.431	16.123
URB	45.011	16.728	11.776	89.37	0.216	2.835
INT	25.83	17.26	1.248	64.803	0.567	2.190
FDI	3.681	4.525	-6.369	28.216	3.120	15.865

Source : Authors' estimation

Note: Mean: average; SD: standard deviation; Min: minimum; Max: maximum. GINDEX: Political inclusion gender index. DINDEX: Democracy index, TRA: Trade. INT: Internet, FDI: Foreign direct investment, GDP: Gross domestic product, URB: Urbanization.

Table A4 in the Appendix presents the correlation matrix and the variance inflation factor of all the variables included in our study to identify the presence of multicollinearity problems. The results show that the overall correlation levels between all the variables are quite low,

indicating that there are no serious problems of multicollinearity. At the same time, the results of the VIF test confirm that there is no multicollinearity between the independent variables.

4.2 Baseline Regression Results

The results of the different panel estimation approaches (POLS, FEOLS, DOLS and FE (D-K S.E) are presented in Table 2. These methods yield almost the same coefficient values. The results show that gender mainstreaming has a positive and significant impact on environmental performance. The effects vary from 4.9469, 4.159, 2.140 and 4.159 in the case of POLS, FEOLS, DOLS and FE (D-K S.E), respectively. The positive and significant signs of the coefficients confirm the results obtained in the literature. Democracy has a positive and significant effect on environmental performance. The coefficients vary from 3.2053, 3.270, 3.302 and 3.270 in the case of OLS, FE (D-K S.E), respectively.

Table 2: Results of the baseline models

Variables	POLS	FMOLS	DOLS	FE (D-K S.E)
GINDEX	4.946*** (1.669)	4.159*** (1.403)	5.140*** 1.354	4.159*** (1.733)
DINDEX	3.2053*** (0.670)	3.270*** (0.096)	3.302*** 0.607	3.270*** (0.065)
TRA	-0.143*** (0.0386)	-0.173 (0.129))	-.259 1.205	-0.173 (0.119)
INT	0.225*** (0.0778)	0.464*** (0.147)	-.951 1.094	0.464 (0.378)
FDI	0.180 (0.257)	0.150 (0.380)	1.080 3.255	0.1503 (0.099)
GDP	1.61e-06 (1.19e-06)	7.63e-06** (4.20e-06)	-0.00001 0.00003	7.63e-06** (1.29e-06)
URB	-2.989*** (1.073)	-1.590 (2.284)	-4.898 11.151	-1.590 (0.795)
N	117	117	117	117
R2	0.6976	0.5263	0.516	0.427

Source: Authors' estimation

Note: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1.GINDEX: Political inclusive gender index. DINDEX: Democracy index, TRA: Trade. INT: Internet, FDI: Foreign direct investment, GDP: Gross domestic product, URB: Urbanization.

4.3. Robustness Check

Table 3 shows the results of the panel quantile regression method of moments. Firstly, the positive impact of political inclusion of gender on EPI can be verified. For all quantiles, the table clearly describes that the increase in EPI due to political inclusion of gender is considerable, rising from 3.70 to 6.381 as the quantile increases. This result is consistent with

that of Asongu et al. (2022). Concerning democracy, there is a positive influence on all quantiles. Democracy is involved in the promotion of environmental performance measures. This result is consistent with that obtained in the literature (Obydenkova et *al.*, 2016; Cai et *al.*, 2020). For control variables such as trade, the effect is negative and statistically negative for all quantiles. However, the intensity of the effect decreases with quantiles. For the internet, the effect is positive for quantiles less than or equal to 75%.

Table 3: results of the panel quantile regression method of moments (Dependent variable EPI)

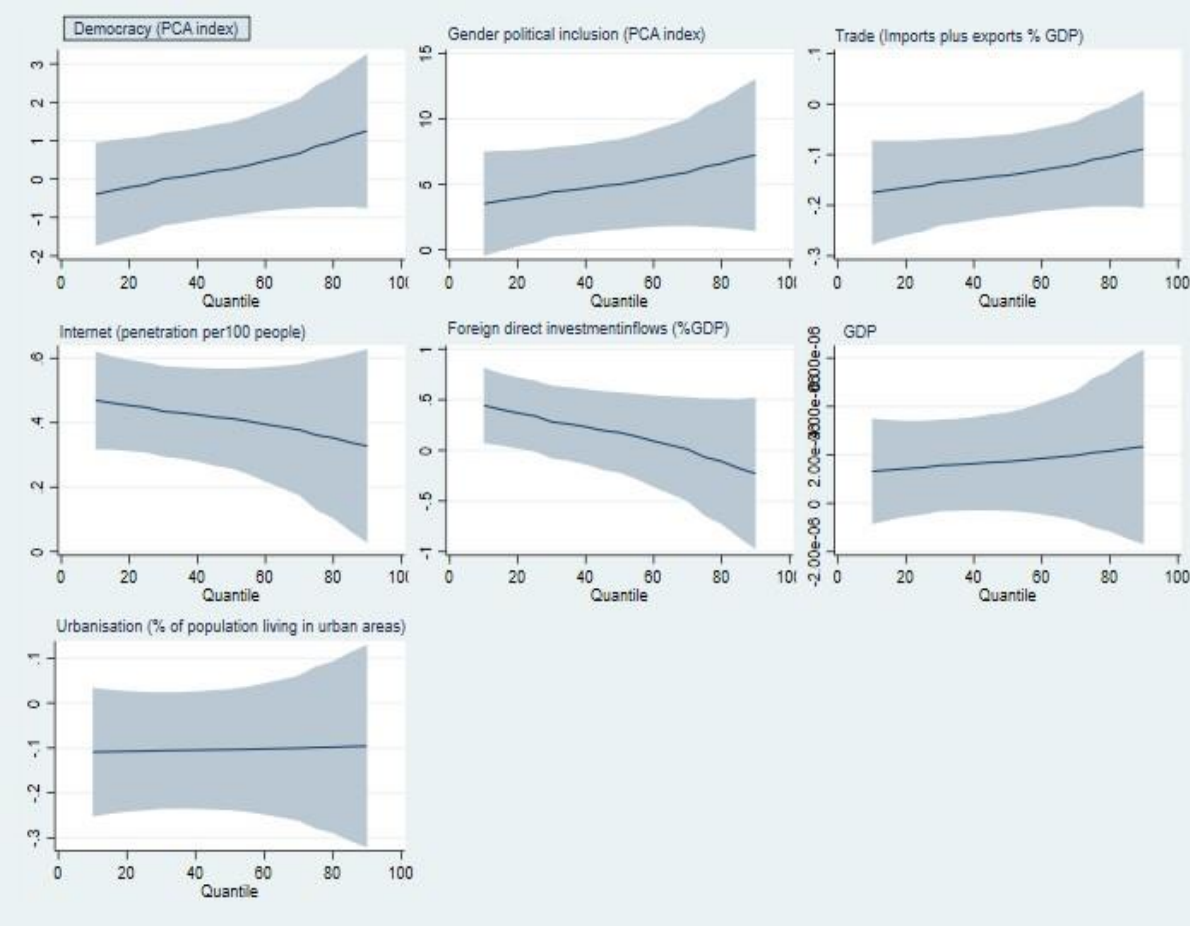
Variables	.10	.25	.50	.75	.90
GINDEX	3.700***	4.189***	4.965***	5.707***	6.381***
	(0.528)	(0.739)	(1.550)	(1.751)	(2.170)
DINDEX	3.197***	3.960***	3.991***	4.511	6.192***
	(0.882)	(0.7570)	(0.674)	(1.7604)	(1.943)
TRA	-0.186***	-0.169***	-0.142***	-0.117***	-0.094*
	(0.051)	(0.0439)	(0.039)	(0.0444)	(0.055)
INT	0.327***	0.287***	0.2243***	0.163***	0.108
	(0.096)	(0.0829)	(0.0743)	(0.0842)	(0.104)
FDI	0.422	0.327	0.176	0.032	-0.098
	(0.291)	(0.249)	(0.223)	0.252)	(0.312)
GDP	1.42e-06	1.49e-06	1.61e-06	1.72e-06	1.83e-06
	(1.54e-06)	(1.32e-06)	(1.18e-06)	(1.33e-06)	(1.65e-06)
URB	-1.842	-2.292*	-3.0067***	-3.690***	-4.310***
	(1.429)	(1.225)	(1.094)	(1.237)	(1.532)
N	117	117	117	117	117

Source: Authors' estimation

Note: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1.GINDEX: Political inclusive gender index. DINDEX: Democracy index, TRA: Trade. INT: Internet, FDI: Foreign direct investment, GDP: Gross domestic product, URB: Urbanization.

Figure 2 shows the coefficients across all quantiles and the corresponding 95% confidence interval for all independent variables. The figure shows that the signs and significance of the quantile regression of the moments' coefficients are generally consistent with those observed in the baseline estimates.

Figure 2: Method of Moments Panel Quantile Regression results



Source: Source: Authors' computation

To test the robustness of our results, we proceeded to estimate the two sub-indices that make up the EPI variable, namely environmental health and ecosystem vitality (Table 4). The results of the simulations show that democracy and gender political inclusion both have positive effects on environmental health and ecosystem vitality. However, gender political inclusion has the largest effect on both dimensions. For the control variables, the effect is positive and statistically significant for all quantiles of order less than or equal to 50%. Internet use also has a positive and statistically significant effect for quantiles less than or equal to 50%.

Table 4: Robustness test for policy objectives (dependent variables: ECOSV and ENH)

Variables	1 (.10)	2 (.10)	1 (.25)	2 (.25)	1 (.50)	2 (.50)	1 (.75)	2 (.75)	1 (.90)	2 (.90)
GINDEX	3.147*** (1.576)	3.017*** (1.568)	4.366*** (1.557)	4.125*** (0.887)	5.842*** (1.926)	5.675*** (1.985)	9.914*** (2.921)	9.178* (2.909)	12.650*** (3.679)	11.629*** (3.309)
DINDEX	2.227*** (0.828)	2.161*** (0.236)	3.196*** (0.991)	3.297*** (0.815)	3.869*** (1.002)	3.540*** (1.000)	4.607*** (1.125)	4.174*** (1.689)	6.902*** (1.956)	5.873*** (1.835)
TRA	-0.139*** (0.050)	-0.215*** (0.075)	-0.130*** (0.048)	-0.194*** (0.062)	-0.111*** (0.0497)	-0.158*** (0.045)	-0.081 (0.068)	-0.139* (0.044)	-0.060 (0.087)	-0.109** (0.054)
INT	0.223*** (0.082)	0.355*** (0.134)	0.218*** (0.080)	0.295*** (0.110)	0.207*** (0.096)	0.187*** (0.0803	0.189 (0.157)	0.128 (0.0784)	0.178 (0.207)	0.040 (0.100)
FDI	0.375** (0.186)	0.549 (0.403)	0.232 (0.193)	0.511 (0.345)	-0.057 (0.237)	0.444 (0.2906	-0.535 (0.364)	0.407 (0.297)	-0.856** (0.459)	0.352 (0.353)
GDP	1.78e-06 (9.80e-07)	1.65e-06*** (1.64e-06)	1.89e-06** (9.42e-07	1.41e-06 (1.44e-06)	2.12e-06*** (1.00e-06)	9.69e-07 (1.37e-06)	2.49e-06* (1.42e-06)	7.29e-07 (1.50e-06)	2.73e-06 (1.80e-06)	3.70e-07 (1.83e-06)
URB	-2.358 (1.267)	-1.152*** (1.650)	-3.033*** (1.244)	-1.236 (1.353)	-4.403*** (1.376)	-1.386 (1.001)	-6.657*** (1.816)	-1.469 (0.9805)	-8.172*** (2.206)	-1.592 (1.206)
N	117	117	117	117	117	117	117	117	117	117

Source: Authors' estimation

Note: Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. 1. represent the environmental heath variable, 2 represent the ecosystem vitality variable. GINDEX: Political inclusive gender index. DINDEX: Democracy index, TRA: Trade. INT: Internet, FDI: Foreign direct investment, GDP: Gross domestic product, URB: Urbanization.

The result of this study on the positive nexus between gender political inclusion and environmental sustainability is in line with the extant empirical and theoretical literature discussed in Section 2, especially in the light of the importance of gender inclusion in favorable outcomes of economic development, *inter alia*, the theoretical relevance of female inclusion in positive economic and political ramifications (Scheyven, 1999; Duflo *et al*., 2012) as well as the empirical literature on the relevance of gender inclusion in better prospects for good governance (Hessami and da Fonseca, 2020; Ngouhouo and Njoya, 2020; Kengdo *et al*., 2020; Nchofoung *et al*., 2023a), more tax mobilization in event of enhanced female empowerment (Asongu *et al*., 2021b); better gender inclusion for health and food security (Yaya *et al*., 2020), infrastructure development (Nchofoung *et al*., 2023b), environmental sustainability (Achuo *et al*., 2021; Asongu *et al*., 2022) and economic freedom (Nchofoung *et al*., 2021).

It is important to note that the findings in this study show that gender political inclusion and democracy drive environmental performance. Hence, the findings demonstrate that enhanced gender inclusion is linked to more economic development within the remit of environmental sustainability. The debate about whether rapid economic development engenders greater female political inclusion is not considered in the study and hence, can be a subject of future research. The established findings thus, run counter to the extant literature positing that

substantive female representation is not associated with more favorable institutional and macroeconomic externalities (Weldon 2002; Celis and Childs 2008; Stoffel 2008; Squires 2008; Htun and Weldon 2010, 2011; Rivas, 2013; Xu, 2015; Kodila-Tedika and Asongu, 2017).

5. Conclusion, recommendations and future research directions

The main objective of this paper has been to examine the role of gender political inclusion and democracy on environment performance using the regression quantile method of moments throughout the conditional distribution of environmental performance in 45 African countries for the period 1992-2018.

The model estimates provide evidence of a positive trade-off between gender political inclusion, democracy and environmental performance. The decomposition of the effects confirms the dominance of the effect of gender political inclusion on democracy. Considering environmental performance under these two broad components, we find that gender political inclusion and democracy positively and significantly affect environmental health and ecosystem vitality. However, the effect of gender political inclusion is more important than the effect of democracy on environmental health and ecosystem vitality. As a main policy implication, gender inclusion should be promoted simultaneously with democratic institutions in order to engender positive effects on environmental sustainability.

This study obviously leaves space for future research especially in the light of assessing how environment sustainability can be affected by female economic inclusion, contingent on other policy or moderating variables as well as alternative governance channels. Moreover, exploring how democracy and political inclusion affect other sustainable development goals (SDGs), is also worth considering in future research. While the established findings point to the direction of gender political inclusion and democracy positively influencing environmental performance, future studies can consider assessing the other way round, especially as it pertains to assessing whether rapid economic development engenders greater female political inclusion.

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Appendix

Table A1: List of countries

Algeria	Gambia	Nigeria
Angola	Ghana	Rwanda
Benin	Guinea	Senegal
Botswana	Kenya	Seychelles
Burkina	Lesotho	Sierra Leone
Burundi	Liberia	South Africa
Cape Verde	Libya	Sudan
Cameroon	Madagascar	Tanzania
Republic of central africa	Malawi	Togo
Comoros	Mali	Tunisia
Republic Democratif of Congo	Mauritania	Uganda
Congo Republic	Maurice	Zambia
Ivory Coast	Morocco	Zimbabwe
Egypt	Mozambique	
Ethiopia	Namibia	
Gabon	Niger	

Source : Authors' compilation

Table A2: List of variables

Variables	Description	Sources
EPI	The Environmental Performance Index, 2020	Wolf et al. (2022)
ENH	Environmental health	Wolf et al. (2022)
ECOSV	Economic system vitality	Wolf et al. (2022)
GINDEX	The Gender of political inclusive index is a composite index following principal component analysis (PCA) to derive a weighting methodology, which better reflects the impact gender variable and dimension on the aggregate index(Table A3).	Aurthors
DINDEX	The Democracy index is a composite index following principal component analysis (PCA) to derive a weighting methodology, which better reflects the impact democracy variable and dimension on the aggregate index(Table A4).	Authors
GDP	GDP per capita at purchasing power parity	World Bank
URB	Urban Percentage of population living in urban areas	World Bank
INT	Internet penetration (per 100 people)	World Bank
FDI	Foreign direct investment inflows (% of GDP)	World Bank

Source : Authors' compilation

Table A3 :Genderpolitical inclusion (Principal Component Analysis)

Comp	Eigenvalue	Variability (%)	Cumulative
1	2.903	72.572	72.572
2	0.951	23.767	96.339
3	0.139	3.471	99.810
4	0.008	0.190	100.000

Source: Authors' calculations

Note: Proportion represents the share of each component. Cumulative represents the sum of the increasing proportions. F1, F2 and F3 are factorial axes of the component matrix.

Table A5: Democracy (Principal Component Analysis)

Comp	Eigenvalue	Proportion	Cumulative
1	1.971	65.689	65.689
2	1.029	34.211	99.900
3	0.003	0.100	100.000

Source: Authors' calculations.

Note: Proportion represents the share of each component. Cumulative represents the sum of the increasing proportions. F1, F2 and F3 are factorial axes of the component matrix.

Table A4: Correlation matrix and variance inflation factor

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**VIF**	**1/VIF**
EPI	1.000								-	
GINDEX	0.220	1.000							1.07	0.93
DINDEX	0.053	-0.214	1.000						1.09	0.91
GDP	0.044	0.017	-0.045	1.000					1.04	0.96
URB	0.166	0.108	0.053	-0.012	1.000				1.53	0.65
INT	0.319	0.055	0.093	-0.164	0.674	1.000			1.73	0.56
FDI	-0.117	0.0004	-0.148	0.079	-0.006	-0.037	1.000		1.33	0.75
TRA	-0.125	0.133	-0.092	-0.013	-0.253	0.392	0.315	1.000	1.57	0.63
Mean									1.34	

Source: Authors' compilation