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Effects of women's political empowerment on environmental crime in developing countries

François-Cyrille EYEGHE-NTOUTOUME

cyrilleeyeghe64@gmail.com

Omar Bongo University- CIREGED

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Abstract

The role of women's political empowerment is attracting growing interest in the literature due to its potential implications for governance and sustainable development. However, its influence on environmental crime remains largely unexplored in the context of developing countries. This study aims to address this gap by analysing the relationship between women's political empowerment and environmental crime across a panel of 65 developing countries over the period 2000–2022. The empirical analysis is based on panel data models incorporating fixed effects, allowing for the control of unobserved heterogeneity across countries. The results show that women's political empowerment is associated with a significant reduction in environmental crime. This finding suggests that increased participation by women in political processes contributes to more environmentally friendly behaviours and policies. These findings also highlight the importance of promoting women's political participation as a lever for strengthening environmental governance. They also call for greater consideration of institutional and economic dimensions in policies to combat environmental crime.

1. Introduction

Environmental crime constitutes today a major challenge for sustainable development, particularly in developing countries (DCs), where it threatens both ecosystems, natural resources, and economic stability (UNEP, 2016). It encompasses all illegal activities that harm the environment, such as the unauthorised exploitation of natural resources, illegal deforestation, illegal fishing, or industrial pollution in violation of prevailing regulations (White, 2008). In this context, the literature identifies several factors explaining environmental crime. From an economic perspective, growth may exert ambivalent effects: while it is essential for development, it also increases pressure on natural resources in the early stages of development, in line with the Environmental Kuznets Curve hypothesis (Grossman and Krueger, 1995). Dependence on natural resource rents may encourage opportunistic behaviour and illegal activities (Auty, 2001; Ross, 2001). From a social perspective, inequalities, particularly gender inequalities, and low levels of human capital increase populations' vulnerability to illegal practices and limit their capacity to oppose environmental degradation (Klasen, 2002). From a financial perspective, the development of credit and investment may both stimulate growth and facilitate the financing of unregulated extractive activities (Levine et al., 2000). Finally, institutional dimensions play a central role: corruption, weak institutions and ineffective control mechanisms foster environmental crime (Kaufmann et al., 2010). In this regard, women's political empowerment emerges as a potential lever for reducing environmental crime. It is defined as the capacity of women to participate fully in political processes, to access decision-making positions, and to exercise their civil and political rights (Sen, 1999; Kabeer, 1999). For their part, Sundström et al. (2017) define women's political empowerment according to three dimensions. The first encompasses civil liberties, the second takes into account participation in economic and social life, and finally, the third concerns the political representation of women within decision-making bodies. The literature shows that women in institutions tend to promote more transparent and effective policies and to reduce corruption (Dollar et al., 2001; Swamy et al., 2001). However, their participation varies significantly across regions: it exceeds 30% in the parliaments of Latin America, stands at around 25% in Sub-Saharan Africa, is close to 20% in Asia, and remains below 20% in the Middle East and North Africa (MENA) region (IPU, 2023). These disparities reflect institutional, cultural and sociopolitical differences that may modulate the effect of women's political empowerment on environmental crime.

Moreover, the theoretical analysis draws on several complementary frameworks. The economic theory of crime (Becker, 1968) suggests that illegal behaviour results from a trade-off between expected gains and costs. Institutionalism (North, 1990; Ostrom, 1990) emphasises the role of institutions in regulating resource exploitation and limiting opportunistic behaviour. The theory of human development and empowerment (Sen, 1999; Kabeer, 1999) highlights that expanding women's capabilities improves the quality of collective choices. Gender political economy (Dollar et al., 2001; Swamy et al., 2001) shows that women's participation reduces corruption and strengthens governance. Finally, the natural resource curse theory (Auty, 2001; Ross, 2001) explains how resource-rich countries may experience negative institutional and economic consequences, indirectly fostering environmental crime. Among these economic theories, our study is primarily based on the natural resource curse theory combined with gender and governance theories. This combination makes it possible to explain both: (i) the structural causes of environmental crime in resource-rich developing countries and (ii) the moderating role of women's political empowerment in limiting such illicit behaviours, through more effective governance and improved enforcement of regulations.

In this context, the central research question of this study is: ***what is the influence of women's political empowerment on environmental crime in developing countries***? Based on the theoretical framework, we formulate the following main hypothesis: ***greater women's political empowerment contributes to reducing environmental crime in developing countries.***

This study contributes to the literature in three main ways. First, it extends existing work by providing one of the first empirical analyses of the relationship between women's political empowerment and environmental crime, a topic that remains largely underexplored. Second, it offers new insights by showing that women's political empowerment, which is generally analysed from the perspective of governance or corruption, may also influence environmental crime. Third, by relying on a panel of developing countries and controlling for unobserved heterogeneity using a fixed effects model, this study provides robust empirical results on how women's political empowerment is associated with environmental crime, while taking into account institutional and regional contexts.

The remainder of the article is organised as follows: Section 2 presents the literature review; Section 3 describes the data and the econometric methodology; Section 4 presents the empirical results; and finally, Section 5 concludes.

2. Literature Review

2.1 Women's Political Empowerment and Governance Quality

The economic and political literature highlights a positive relationship between women's political empowerment and the quality of governance (Rajan, 2003). The increase in women's participation in political institutions is generally associated with improved institutional performance, particularly in terms of transparency, accountability and the control of corruption (Mechkova et al., 2024). For example, Tabellini (2003) emphasises that the quality of institutions is strongly correlated with social values and governance norms, among which political inclusion plays a central role. Similarly, Dollar et al. (2001) find that women are associated with lower levels of corruption in public office.

In the same vein, Abdoullaye (2025) analyses the relationship between women's political empowerment and political corruption in Africa using a panel of 52 countries (1994–2024). Employing the system GMM method, the results show that greater women's political participation is significantly associated with a reduction in corruption, although this effect depends on the context. Similarly, Shah (2007) shows that women tend to promote more transparent public policies that are more oriented towards collective welfare.

This finding is also supported by Duflo (2012), who highlights that women's involvement in governance improves and strengthens the quality of public decision-making.

For their part, Rios et al. (2023) examine the relationship between women's political empowerment and governance quality in European regions, taking into account endogeneity and spatial interdependencies. Using instrumental variables constructed through random forest techniques, the authors show the existence of a bidirectional relationship: women's political empowerment improves governance quality, which in turn strengthens women's political participation.

Moreover, the literature on political representation also confirms these findings. Pippa and Inglehart (2001) show that an increase in women's participation in the political sphere is associated with more inclusive and democratic political systems. Similarly, Chattopadhyay and Durlauf (2010) highlight that the inclusion of women in decision-making processes contributes to improving governance by strengthening institutional control mechanisms. In addition, Rose-Ackerman (1999), in her work on corruption and governance, emphasises the importance of institutional and social characteristics in limiting opportunistic behaviour. In this context, women's political empowerment is often associated with stricter norms of public integrity. In addition, recent empirical studies, notably those of Anderson and Fong (2018), confirm that increased women's participation in political life is associated with improvements in governance quality, particularly in developing countries, where institutions are often more fragile.

Moreover, some studies suggest that women have a lower propensity to engage in corrupt behaviour than men, particularly due to higher risk aversion (Alatas et al., 2009; Esarey and Chirillo, 2013). In this context, greater representation of women in decision-making spheres is likely to enhance the quality of institutions, especially in settings where incentives for corruption are high, by promoting stricter democratic control mechanisms and more rigorous enforcement of sanctions (Esarey and Chirillo, 2013; Esarey and Schwindt-Bayer, 2019).

2.2 Women's Political Empowerment and the Environment

The empirical literature increasingly agrees that women's political empowerment constitutes an important determinant of environmental performance (Niv and Deng, 2019; Fredriksson and Wang, 2011). For example, Mavisakalyan and Tarverdi (2019) show that the presence of women in parliament is associated with more ambitious climate policies as well as a reduction in CO_2 emissions. In the same vein, Asongu et al. (2021) analyse the effect of women's political empowerment on climate vulnerability in 169 countries over the period 1995–2017. The results suggest that women's political empowerment and its components reduce climate vulnerability. Similarly, Ergas and York (2012) find that women are more likely to support environmental policies and sustainable development initiatives, which translates into better environmental performance in countries where they are more politically represented. Comparable results are observed at different scales. Using European data, Rios et al. (2024) show that women's political empowerment is associated with improved air quality, suggesting that their political participation directly influences environmental public policies. Likewise, empirical studies using advanced econometric methods indicate that female representation in political institutions contributes positively to environmental sustainability, particularly through the promotion of green growth policies. In this context, Mamun et al. (2024) analyse the effect of women's political empowerment (WPE) on green finance in a panel of 47 countries over the period 2007–2022. The results show that WPE fosters the development of green bonds.

Moreover, the literature on local leaders also confirms these findings. Chattopadhyay and Duflo (2004) show that women elected at the local level in India invest more in public goods related to water and infrastructure, which has direct implications for natural resource management and environmental quality. In the same vein, Yadav and Lal (2017) highlight that, in arid regions of Asia, women are generally more affected than men following a negative climate-related shock. According to the authors, this situation is explained by the fact that women are poorer, less educated, and have limited access to information,

institutions, and decision-making bodies that influence societal outcomes (Goh, 2012; Asongu et al., 2021). Furthermore, Beaman et al. (2009) suggest that exposure to female leaders improves citizens' preferences in favour of more inclusive public policies, which may indirectly influence environmental policies.

Other contributions highlight the existence of a critical mass effect. Kandemir et al. (2024) show that the positive impact of women on environmental policies becomes significant beyond a certain threshold of parliamentary representation, generally around 30%. This suggests that the effects of women's political empowerment are not merely marginal, but depend on their ability to effectively influence political decision-making.

3. Methodological strategy

We present the empirical models as well as the data collected.

3.1 Empirical model

In order to analyse the effects of women's political empowerment on environmental crime, we draw on the work of Awoa Awoa et al. (2022), which examines the existence of a relationship between women's political empowerment and the natural resource curse in a panel of 130 developing countries over the period 2002–2017. Using the two-step system GMM, the results show that total resource rents per capita have a significant negative impact on overall women's political empowerment.

- **Dependent variable**

The dependent variable in our study is environmental crime, a multidimensional phenomenon that is difficult to measure directly due to its illegal nature and the limited availability of data. It encompasses several dimensions, including wildlife-related crime, pollution-related crime, illegal fishing, and forest-related crime. In this study, we use forest cover loss ≥30% (Treecoverloss) as an indirect measure, which constitutes a relevant approximation of environmental crime related to potentially illegal deforestation. This choice is consistent with the literature that uses proxy indicators to capture unobservable phenomena (Wooldridge, 2010). Furthermore, to test the robustness of the results, we use alternative proxies, namely air pollution measured by fine particulate matter concentrations (PM2.5), as an indirect proxy for pollution-related crime, as well as natural resource rents (as a percentage of GDP). These indicators allow us to capture other forms of environmental pressure and degradation. Although these indirect measures do not directly capture all dimensions of environmental crime, they are commonly used proxies in the literature.

- **independent variable**

Our main independent variable is women's political empowerment. To measure it, we use the Women's Political Empowerment Index (autofemme), which ranges between 0 and 1 and captures the level of women's participation and influence in the political process. A value close to 1 indicates a high level of empowerment, whereas a value close to 0 reflects low political inclusion of women. Furthermore, for robustness analyses, we also use the share of women in parliament (wparl), expressed as a percentage, which serves as an alternative indicator of women's political representation and allows us to test the robustness of the results.

- **Control variables**

Our control variables, grouped in the vector X, are recognised in the literature as influencing environmental crime. Indeed, the level of economic development, measured by GDP, is included to capture environmental pressures associated with economic activity, in line with the literature on the Environmental Kuznets Curve (Grossman and Krueger, 1995). The control of corruption (cc) is included

to reflect the quality of governance and its role in enforcing environmental regulations and combating illegal activities (Kaufmann et al., 2010; Fisman and Gatti, 2002). International trade (logci) is included to capture the effects of economic openness on environmental pressures, particularly through mechanisms of specialisation and pollution displacement (Copeland and Taylor, 2004). The share of agriculture in GDP (logagri) is used to account for dependence on natural resources and the intensity of activities that may affect the environment, particularly in developing economies (Sachs and Warner, 2001). Finally, total population (pop) is included to capture demographic pressure on natural resources and its effects on environmental degradation (Malthus, 1798; Ehrlich and Holdren, 1971).

- **Omitted variables**

In addition to the control variables, we include three additional variables to reduce omitted variable bias. Official development assistance (adp) is included to capture the influence of international aid flows on economic and institutional dynamics, which are often associated with improvements in governance (Dollar and Kraay, 2002). Political stability (sp) is also introduced to reflect the quality of the institutional environment, a key determinant of the implementation of public policies and the regulation of illegal activities (Kaufmann et al., 2010). Finally, foreign direct investment (fdi) is included to account for the effects of economic openness on environmental pressures. The literature highlights the "pollution haven" hypothesis, according to which pollution-intensive firms tend to relocate to countries with less stringent environmental regulations (Panayotou, 1997; Eskeland and Harrison, 2003).

For estimation purposes, the relationship between women's political empowerment and environmental crime can be expressed as follows:

$$Treecoverloss_{i,t} = \beta_0 + \beta_1 autofemme_{i,t} + \beta_2 X_{i,t} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (1)$$

With :

- $Treecoverloss_{i,t}$: Environmental crime (forest cover loss);
- $autofemme_{i,t}$: Women's political empowerment;
- $X_{i,t}$: set of control variables;
- μ_i : country fixed effects;
- γ_t : time fixed effects;
- $\varepsilon_{i,t}$: error term;
- i represents the country and t represents time.

3.2 Estimation Technique

In this study, we employ panel data models in order to exploit the longitudinal dimension of the sample and to account for unobserved heterogeneity across countries. More specifically, we consider both fixed effects and random effects specifications, which respectively control for unobserved time-invariant characteristics. The choice between these two approaches is made using the Hausman test, which allows us to assess the existence of a correlation between individual effects and the explanatory variables. The use of these models is particularly relevant for analysing the relationship between women's political empowerment and environmental crime, as these phenomena are likely to be influenced by unobserved institutional, cultural, or structural characteristics that remain constant over time. By controlling for these factors, panel data models help to reduce omitted variable bias and improve the reliability of the estimates under the assumption of strict exogeneity of the explanatory variables. Furthermore, the estimations are conducted using robust standard errors in order to correct for potential heteroskedasticity and autocorrelation. However, this approach presents certain limitations, particularly in the presence of endogeneity issues such as reverse causality or omitted time-varying variables, which may bias the

estimates. Indeed, it is plausible that environmental crime may also influence women's political empowerment, thereby introducing simultaneity into the relationship under investigation. To address these endogeneity concerns, we complement our analysis with the two-step system GMM estimator, which accounts for the endogeneity of explanatory variables, the dynamic nature of the model, and the possible presence of measurement errors. This approach combines equations in first differences and in levels and relies on valid internal instruments to improve the consistency and efficiency of the estimators (Arellano and Bond, 1998). Moreover, an excessive number of instruments may lead to overidentification problems, potentially affecting the validity of the Hansen test and compromising the robustness of the results. To mitigate this issue, we apply the instrument collapse procedure recommended in the literature, which reduces the number of instruments by grouping them, thereby limiting instrument proliferation and improving the reliability of the estimates (Roodman, 2009).

3.3 Data

The data used in this study are drawn from secondary sources. More specifically, data on forest cover loss are obtained from Global Forest Watch, while those relating to women's political empowerment are sourced from the V-Dem database. Furthermore, data on economic growth, total population, control of corruption, and international trade are obtained from the World Bank. Finally, data on agriculture are sourced from the FAO.

Table 1 : List of countries in the study

Afghanistan; Algeria; Angola; Bangladesh; Benin; Bolivia; Botswana; Brazil; Burkina Faso; Burundi; Cabo Verde; Cambodia; Cameroon; Chile; China; Colombia; Comoros; Democratic Republic of the Congo; Ecuador; Egypt; Ethiopia; Gabon; Ghana; Guatemala; Guinea; Guinea-Bissau; Haiti; Honduras; India; Indonesia; Jamaica; Kenya; Lesotho; Madagascar; Malaysia; Mali; Mauritania; Mauritius; Mexico; Mongolia; Morocco; Namibia; Nepal; Niger; Pakistan; Panama; Paraguay; Peru; Philippines; Republic of the Congo; Rwanda; Senegal; Sierra Leone; South Africa; Sri Lanka; Suriname; Tanzania; Thailand; The Gambia; Togo; Uganda; Uruguay; Viet Nam; Zambia; Zimbabwe

Source : author

Table 2 : Descriptive statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
Treecoverloss	1495	.842	.106	.39	.99
autofemme	1495	.8	.173	.048	1
PIB	1495	4.164	4.178	-20.805	28.6
cc	1495	-.549	.612	-1.937	1.611
logci	1495	1.784	.202	1.236	2.343
pop	1495	1.92	.971	-.92	7.541
logagri	1495	1.565	.336	-.348	1.933
Variables additionnelles					
adp	1495	873.585	1075.108	-1006.74	7941.39
ide	1495	-3.897	16.091	-231.652	41.675

spav	1495	-.503	.815	-2.81	1.224

Source: author

The results in **Table 2** show that forest cover loss (Treecoverloss) has a mean of 0.842, associated with low dispersion (st dev = 0.106), suggesting that deforestation is relatively homogeneous across the developing countries considered. Indeed, the observed values range from 0.39 to 0.99, indicating that, despite some differences, most developing countries are characterised by high levels of forest loss. Furthermore, the indicator of women's political empowerment (autofemme) displays a mean of 0.8 with a standard deviation of 0.173, reflecting greater dispersion than that observed for deforestation. The values range from 0.048 to 1, revealing significant heterogeneity across countries in terms of women's political empowerment.

4. Analysis of Results

4.1 Results of the Baseline Model

Table 3: Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Treecoverloss	1.000						
(2) autofemme	-0.158*	1.000					
(3) PIB	0.009	0.046*	1.000				
(4) cc	-0.035	0.149*	0.008	1.000			
(5) logci	-0.011	0.022	0.032	0.209*	1.000		
(6) pop	0.454*	-0.163*	0.134*	-0.403*	-0.168*	1.000	
(7) logagri	-0.234*	0.057*	0.045*	-0.045*	-0.140*	-0.012	1.000
Mean vif			**1.11**				

**** p<0.01, ** p<0.05, * p<0.1*

Source : author

The results in **Table 3** indicate that the relationships between the explanatory variables are generally weak, suggesting the absence of problematic multicollinearity. This conclusion is confirmed by the low value of the mean VIF (1.11), which is well below the critical threshold of 5, indicating that the variables are not highly correlated with each other.

Table 4 : Hausman test

The results in **Table 4** (Appendix A) of the Hausman test indicate that the Chi-square statistic is equal to 19.10 with a p-value of 0.004. The null hypothesis of no correlation between the individual effects and the explanatory variables is rejected at the 5% significance level, leading us to prefer the fixed effects model.

Table 5 : Estimation

	(1)
autofemme	**-.03988*****
	(.0119)
PIB	**.00021***
	(.00011)
cc	.00177
	(.00563)
logci	.00382
	(.01103)
pop	**.0089*****
	(.00326)
logagri	-.04035
	(.08895)

Constant	**.91358***** (.13465)
R-squared	0.16913
F-test	3.36967
Number of obs	1495
Number id	65
Prob > F	0.00917

*** *p<.01, ** p<.05, * p<.1*
Source: author

The results presented in **Table 5** are derived from a fixed effects model estimated with cluster-robust standard errors at the individual level, in order to correct for heteroskedasticity and intra-group autocorrelation. Moreover, the results suggest that the model is globally significant, as indicated by the Fisher test. The R-squared shows that the model explains about 16.9% of the variation in forest cover loss.

Furthermore, the results show that women's political empowerment (autofemme) is statistically significant and negatively associated with forest cover loss at the 1% significance level. Indeed, a one-unit increase in women's political empowerment leads to a reduction of 0.03988 units in deforestation. In other words, a greater presence or influence of women appears to contribute to reducing deforestation. These findings are consistent with the work of Shandra et al. (2008), who, in a panel of 61 countries over the period 1990–2005, find that countries with higher levels of women's political empowerment tend to exhibit lower deforestation rates. In addition, economic growth (GDP) is statistically significant and positive at the 10% level, indicating that a one-unit increase in economic growth leads to an increase of 0.00021 units in deforestation. This result is in line with Cuaresma and Heger (2019), who, based on a sample of 14 contiguous countries, show that economic development in developing countries is, on average, associated with an increase in forest cover loss.

Moreover, total population has a positive and significant effect on deforestation at the 1% level. This finding is consistent with the work of Laurance et al. (2014) and Carr (2004), who highlight a positive relationship between demographic pressure and deforestation in tropical forests.

4.2 Robustness and sensitivity analysis

The robustness analysis is based on a series of five tests, namely: the inclusion of an alternative indicator of women's political empowerment, the modification of the measure of environmental crime, the gradual addition of control variables, the introduction of additional variables, and the use of alternative estimation methods. Furthermore, the analysis of heterogeneity reveals differences across regions and income levels.

- ***Robustness through the inclusion of an alternative indicator of women's political empowerment***

In order to test the robustness of our results, we re-specify the model by introducing an alternative measure of women's political empowerment. In this regard, we use the percentage of women in parliament (wparl) as an indicator. The results reported in **Table 6** (Appendix B) confirm the robustness of our findings.

- ***Robustness through the modification of the measure of environmental crime***

In order to test the robustness of our results, we modify the measurement of environmental crime by using alternative indicators, namely fine particulate air pollution (PM2.5) and natural resource rents (as a percentage of GDP). It should be noted, however, that these variables do not constitute direct measures of environmental crime. Rather, they are considered indirect indicators that may reflect certain forms of environmental pressure associated with illegal or weakly regulated activities. Indeed, several studies have shown that air pollution, particularly fine particulate emissions, is closely linked to environmental regulatory failures and non-compliance with standards, often observed in contexts of weak governance

(Cole and Elliott, 2003; Dietrich Vollmer et al., 2016). Such conditions may encourage practices that can be associated with environmental crime. Similarly, natural resource rents are often linked to intensive—and sometimes illegal—resource exploitation, especially in developing countries. The literature on the "natural resource curse" highlights that resource abundance may be associated with governance problems, corruption, and unregulated extractive activities (Sachs and Warner, 2001; Auty, 1993). Nevertheless, the results should be interpreted with caution due to these measurement limitations.
The results reported in **Table 7** (Appendix C) confirm the robustness of our findings when using these two indirect measures of environmental crime, regardless of the model considered.

- ***Robustness through the gradual inclusion of control variables***

The results presented in **Table 8** (Appendix D) confirm the robustness of the baseline estimates. The gradual inclusion of control variables does not alter either the sign or the significance of the coefficient for women's political empowerment, suggesting that the estimated effect is stable and robust to different model specifications.

- ***Robustness through the inclusion of additional variables***

The results in **Table 9** (Appendix E) highlight that even after the successive inclusion of additional variables, the results remain unchanged.

- ***Robustness to alternative methods***

In order to strengthen the robustness of our results, we employ alternative estimation methods, namely ordinary least squares (OLS), the Driscoll–Kraay estimator, and the two-step system GMM estimator. First, we estimate the model using ordinary least squares (OLS). This approach provides a simple and easily interpretable estimate. However, it has important limitations in the context of panel data, as it does not account for unobserved heterogeneity across countries nor correct for endogeneity issues, which may lead to biased estimates. To address some of these limitations, we use the Driscoll–Kraay estimator, which adjusts standard errors in the presence of heteroskedasticity, autocorrelation, and cross-sectional dependence. This method is particularly well suited to macroeconomic panel data. Nevertheless, although the Driscoll–Kraay estimator improves the robustness of standard errors, it does not correct for potential endogeneity in the explanatory variables. To overcome this issue, we employ the two-step system Generalised Method of Moments (GMM) estimator, which allows us to address endogeneity problems, notably through the use of internal instrumental variables. This approach yields more consistent estimators. However, the results obtained using this method must be interpreted with caution, particularly due to the risks associated with instrument proliferation and the validity of the instruments. To mitigate this issue, we use the collapse option, which reduces the number of instruments (Roodman, 2009).

Furthermore, the results presented in **Table 10** (Appendix F) suggest that the estimates obtained from the alternative methods confirm the robustness of our findings.

- ***Heterogeneity analysis by income level and by geographical regions***

To examine the heterogeneity of the results according to the level of economic development and the regional dimension, we distinguish two groups of countries: lower-middle-income and upper-middle-income countries, following the World Bank classification (2022). In addition, a regional analysis is conducted to compare the results across different geographical areas, namely Sub-Saharan Africa, South Asia, and South America. The results in **Table 11** (Appendix G) present columns 1 and 2, which report the effect of women's political empowerment on environmental crime in lower-middle-income countries and upper-middle-income countries, respectively. Columns 3 to 5 display the results by region, namely Sub-Saharan Africa, South Asia, and South America. Overall, these estimates indicate that the coefficients associated with women's political empowerment remain broadly consistent with those obtained in the

baseline model (**Table 5**). Moreover, the analysis reveals that women's political empowerment has stronger and more persistent negative effects on environmental crime in middle-income countries, as well as in South America.

5. Conclusion

This study examines the effect of women's political empowerment on environmental crime in a panel of 65 developing countries, using fixed effects models as well as several complementary econometric methods. The empirical results reveal a negative and statistically significant effect of women's political empowerment on environmental crime, suggesting that greater participation of women in decision-making processes contributes to environmental protection. This relationship remains robust to the introduction of alternative measures of women's political empowerment and environmental crime, the inclusion of control and additional variables, as well as the use of various estimation methods, including ordinary least squares (OLS), the Driscoll–Kraay estimator, and the two-step system GMM estimator. Furthermore, the heterogeneity analysis reveals that this effect varies according to income level and regions, highlighting the importance of the economic and institutional context in understanding environmental dynamics. These findings have important policy implications. They suggest that strengthening women's political participation can serve as an effective lever to improve environmental governance and reduce activities related to environmental crime. In this regard, governments in developing countries would benefit from promoting the inclusion of women in decision-making spheres, while also strengthening institutional quality and environmental regulatory mechanisms.

However, this study presents certain limitations. On the one hand, the measurement of environmental crime is partly based on indirect indicators, which may limit the precision of the results. On the other hand, the analysis does not account for certain specific forms of environmental crime, such as illegal fishing or the illicit wildlife trade. Taking these dimensions into account would allow for a more refined measurement of the phenomenon under study and a more comprehensive understanding of the dynamics of environmental crime.

In this perspective, future research could further the analysis by employing more disaggregated indicators of environmental crime in order to better capture its different dimensions. Particular attention could be given to specific forms such as illegal fishing, illegal logging, or wildlife trafficking, thereby refining the measurement of the phenomenon under study.

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APPENDIX

Table 4 : Hausman test (appendix A)

	Coefficient	
	Fe	Re
autofemme	-.0398	-.0397
PIB	.0002	.0002
cc	.0018	.0018
logci	.0038	.0038
pop	.0089	.0091
logagri	-.0404	-.0455
chi2(6) test value: **19.10**		
Prob > Chi²: .**004**		

Source : author

Table 6 : Integration of an alternative measure of women's political empowerment (Appendix B)

	(1)
wparl	**-.0008***** (.0002)
PIB	.0001 (.0001)
cc	.0029 (.0052)
logci	.0052 (.0105)
pop	**.0094 ***** (.0033)
logagri	-.0413 (.0782)
Constant	**.8954***** (.8954)
R-squared	0.2303
F-test	5.4006
Number of obs	1495
Prob > F	0.0003
Number id	65

*** *p<.01,* ** *p<.05,* * *p<.1*

Source: author

Table 7 : Robustness through the modification of the measure of environmental crime (appendix C)

	(1)	(2)
autofemme	**-0.176****	**-0.0926***
	(0.0691)	(0.0488)
PIB	**0.00682*****	**0.000818****
	(0.00176)	(0.000404)
cc	-0.0887	0.0166
	(0.0541)	(0.0188)
logci	**0.633*****	0.00642
	(0.166)	(0.0423)
pop	0.0298	**0.0187****
	(0.0212)	(0.00908)
logagri	-0.660	-0.0426
	(0.626)	(0.308)
Constant	0.521	**1.573*****
	(1.067)	(0.468)
Observations	1,495	1,495
R-squared	0.112	0.057
Number of id	65	65
F-test	2.47	8.74
Prob > F	0.0327	0.0000

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source : author

Table 8 : Robustness through the progressive inclusion of control variables (appendix D)

	(1)	(2)	(3)	(4)	(5)
autofemme	**-0.0450*** **	**-0.0449*** **	**-0.0447*** **	**-0.0413*** **	**-0.0399*** **
	(0.0124)	(0.0124)	(0.0123)	(0.0107)	(0.0119)
PIB	**0.000380*** **	**0.000378*** **	**0.000366*** **	**0.000217***	**0.000212***
	(0.000110)	(0.000111)	(0.000117)	(0.000112)	(0.000111)
cc		0.00108	0.00114	0.00119	0.00177
		(0.00580)	(0.00573)	(0.00569)	(0.00563)
logci			0.00299	0.00252	0.00382
			(0.0117)	(0.0112)	(0.0110)
pop				**0.00921*** **	**0.00890*** **
				(0.00323)	(0.00326)
logagri					-0.0404
					(0.0890)
Constant	0.877***	0.877***	0.872***	0.853***	0.914***
	(0.00986)	(0.0102)	(0.0225)	(0.0220)	(0.135)
Observations	1,495	1,495	1,495	1,495	1,495
R-squared	0.105	0.105	0.105	0.165	0.169
Number of id	65	65	65	65	65
F-test	11.21	7.51	5.70	3.67	3.37
Prob > F	0.0001	0.0002	0.0005	0.0055	0.0060

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source : author

Table 9 : Robustness to the inclusion of additional variables. (appendix E)

	(1)	(2)	(3)
autofemme	**-0.0392*** **	**-0.0361*** **	**-0.0360*** **
	(0.0118)	(0.0116)	(0.0116)
PIB	**0.000216***	**0.000226** **	**0.000236** **
	(0.000111)	(0.000108)	(0.000109)
cc	0.00249	0.00258	0.00234
	(0.00550)	(0.00550)	(0.00551)
logci	0.00323	0.00328	0.00422
	(0.0109)	(0.0110)	(0.0109)
pop	**0.00900*** **	**0.00893*** **	**0.00880*** **
	(0.00329)	(0.00322)	(0.00318)
logagri	-0.0403	-0.0365	-0.0336
	(0.0884)	(0.0897)	(0.0885)
sp	-0.00207	-0.00221	-0.00220
	(0.00236)	(0.00236)	(0.00231)
adp		-1.89e-06	-1.92e-06
		(2.19e-06)	(2.13e-06)
ide			0.000134
			(0.000105)
Constant	**0.913*** **	**0.906*** **	**0.901*** **
	(0.134)	(0.135)	(0.134)
Observations	1,495	1,495	1,495
R-squared	0.172	0.177	0.185
Number of id	65	65	65
F-test	2.90	2.59	2.59
Prob > F	0.0108	0.0161	0.0161

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source : author

Table 10 : Robustness to alternative methods (appendix F)

	MCO	Discoll Kraay	GMM en système
L.Treecoverloss			**0.992*** **
			(0.00791)
autofemme	**-0.0527*** **	**-0.0399*** **	**-0.00571***
	(0.0137)	(0.00655)	(0.00339)
PIB	**-0.00124** **	0.000212	6.93e-06
	(0.000563)	(0.000165)	(3.66e-05)
cc	**0.0303*** **	**0.00177** **	-0.000731
	(0.00422)	(0.000673)	(0.000976)
logci	0.00706	0.00382	-0.000607
	(0.0119)	(0.00866)	(0.00188)
pop	**0.0565*** **	**0.00890*** **	-0.00152
	(0.00267)	(0.00270)	(0.00145)
logagri	**-0.0666*** **	**-0.0404*** **	-0.00129
	(0.00699)	(0.0118)	(0.00101)
Constant	**0.890*** **	**0.914*** **	**0.0157** **
	(0.0288)	(0.0327)	(0.00664)
Observations	1,495	1,495	1,430
R-squared	0.291		
Number of groups		65	65
Number of instruments			15
AR(1)			0.000
AR(2)			0.587
P-value Hansen			0.972

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source : author

Table11 : Heterogeneity analysis by income level and across regions (appendix G)

	(1)	(2)	(3)	(4)
	Lower-middle-income	Upper-middle-income	ASS	South Asia
autofemme	**-0.0412****	**-0.0541****	**-0.0417****	**-0.0285****
	(0.0161)	(0.0203)	(0.0163)	(0.00860)
PIB	2.47e-05	0.000346	6.63e-05	-4.08e-05
	(0.000183)	(0.000232)	(0.000112)	(0.000186)
cc	-0.00175	0.00896	0.00770	-0.0656***
	(0.00546)	(0.0102)	(0.00565)	(0.0101)
logci	0.00963	0.0387	-0.00500	-0.0274
	(0.0126)	(0.0276)	(0.00899)	(0.0339)
pop	**0.0129****	**0.0134***	0.00401	0.00869
	(0.00485)	(0.00666)	(0.00300)	(0.00601)
logagri	**-0.266*****	0.134	0.0261	**-0.726*****
	(0.0940)	(0.112)	(0.0613)	(0.0654)
Constant	**1.250*****	**0.595*****	**0.872*****	**2.013*****
	(0.150)	(0.135)	(0.0920)	(0.0882)
Observations	713	414	759	184
R-squared	0.370	0.362	0.152	0.562
Number of id	31	18	33	8

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source : author