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Original article

Leaders background, environmental policy and quality of environment: evidence from some developing countries

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Abstract

This study employs a quasi-experimental methodology, utilizing two-stage residuals regression, propensity score matching (PSM), and difference-in-differences (DiD) techniques to examine the relationship between the leader's background, environmental policy, and environmental performance in some 55 developing countries. The analysis is based on a sample of 189 presidents from 1995 to 2018. The findings of this study demonstrate that the leader's educational and professional background exhibits global variations in estimation techniques, yet the results from environmental policies remain consistent. The results indicate that a leader's background is not a significant factor in environmental performance; rather, environmental response is positively influenced by their actions.

Keywords: leaders background, environmental policy, environmental quality, PSM, DiD.

Data Availability statement: Data supporting the findings of this study are freely available from the corresponding author, upon reasonable request.

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Оригинальная научная статья

Опыт лидеров, экологическая политика и качество окружающей среды: данные из некоторых развивающихся стран

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Аннотация

В этом исследовании используется квазиэкспериментальная методология, использующая двухэтапную регрессию остатков, сопоставление оценок склонности (PSM) и методы разности разностей (DiD) для изучения взаимосвязи между прошлым лидера, экологической политикой и экологическими показателями в 55 развивающихся странах. Анализ основан на выборке из 189 президентов с 1995 по 2018 гг. Результаты этого исследования показывают, что образовательный и профессиональный опыт лидера демонстрирует глобальные различия в методах оценки, однако результаты экологической политики остаются неизменными, а также что прошлое лидера не является значимым фактором в экологических показателях, скорее его действия оказывают положительное влияние на экологическую реакцию.

Ключевые слова: прошлое лидеров, экологическая политика, качество окружающей среды, PSM, DiD

Финансирование. Исследование не имело финансовой поддержки.

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Introduction

In a report published in 2018, the Intergovernmental Panel on Climate Change (IPCC) stated that "political leaders have a responsibility to protect the environment for present and future generations." Nevertheless, the decisions made by these leaders can have a considerable impact on the quality of the environment (IPCC, 2020). As Gro Harlem Brundtland, former Prime Minister of Norway, observed, sustainable development can only be achieved if political leaders make decisions that take into account environmental, social and economic needs (Brundtland Commission, 1987). Those in positions of political leadership are confronted with significant challenges in reconciling the objectives of economic development and the fight against climate change. This leads to the question of do political leaders matters for environmental performance?

One of the key challenges facing leaders is the allocation of scarce public resources between investment projects and programmes. It is not always the case that resources are allocated in accordance with the principles of need or urgency. In some cases, the distribution of resources is based on the preferences of decision-makers, who may be driven by intrinsic motivations shaped by their background. For example, Chattopadhyay and Duflo (2004) demonstrated that, in Indian parliaments, women invest in drinking water and road infrastructure, whereas their male counterparts allocate a greater proportion of their budget to education. This indicates that women are more attuned to the needs of their gender. Similarly, Besley et al. (2013) indicate that leaders with higher levels of education tend to allocate a greater proportion of their budgets towards educational initiatives. Historical analysis indicates that Mugabe's personal experiences of attending Fort Hare University in South Africa and later working as a teacher were the primary motivation for his interest in prioritising education in Zimbabwe and overseeing aspects of Zimbabwe's education policy (Jansen, 2017; Chutel, 2017). As Horowitz and Stam (2014) have observed, military expenditure is positively correlated with the likelihood of armed conflict. A multitude of additional examples can be found throughout the economic literature. However, there is a paucity of knowledge regarding environmental policies.

Another potential explanation for the impact of political leaders on the environment is political. In a democratic context, political leaders may be inclined to prioritise more visible projects in order to enhance their electoral prospects (Dahlum and Knutsen, 2017). For instance, it could be argued that the construction of transport or utility infrastructure may be perceived as a more politically advantageous course of action than the funding of environmental protection.

We can't claim the primacy of this analysis. Previous studies have identified a number of factors that influence leaders' incentives to protect the environment. These include environmental values and beliefs, experience and skills, and political ideology. Political leaders who accord a high priority to environmental issues are more likely to implement ambitious environmental policies (Lafferty & Meadowcroft, 2000). Those with backgrounds in environmental science or related fields are more likely to make informed decisions (Kamieniecki, 2006). Furthermore, president with left-wing ideologies tend to demonstrate greater support for environmental regulation than their right-wing counterparts (Neumayer, 2003).

The extant literature suggests that certain profiles may prove conducive to environmental protection, while others may not. However, the incentives of a leader to preserve the environment do not supplant actions on the ground and thus are insufficient to engender superior environmental performances. For instance, a survey conducted by Biscotti and D'Amico (2016) indicates that

young people possess a greater knowledge of environmental issues but act less to preserve it, unlike older people. Consequently, this study aims to comparatively analyse the environmental impact of profiles of political leaders and the environmental policies they implement.

The study has a double interest:

The study provides new frameworks for comprehending environmental challenges. It addresses the gap in comparing environmental protection determinants and considers the diverse dimensions of political leaders' backgrounds. Moreover, it is a pivotal contribution to the growing literature on the role of political leaders in their country's sustainable development process.

This article makes a significant methodological contribution in the form of an exhaustive database on the backgrounds of leaders in developing countries. The database contains information on more than 184 leaders, providing data on their academic and professional experience. This article employs both an established method, the Two-Stage Residuals Regression approach (Bertrand and Schoar, 2003), and newer techniques commonly utilized in social sciences, epidemiology, and econometrics to quantify the impact of a treatment or intervention. These are the Difference-in-Difference (DiD) and Propensity Score Matching (PSM) methods. These methods are employed for the purpose of measuring causal effects, as opposed to merely identifying correlations. In this context, the differences in results observed between two groups over time are compared (Donald and Lang, 2007). The PSM is an effective method for mitigating selection bias by matching leaders with similar characteristics, thereby ensuring that the treatment (leader's educational and professional background) is randomly assigned (Moran et al., 2024). The efficacy of these methods hinges on their capacity to account for potential confounding variables, including country-specific factors, time trends, and other economic indicators.

The operational interest of this study is the environmental policy recommendations for better decision making in the sustainable development process of developing countries. By analyzing data on over 184 leaders' experiences, the essay extends the empirical research in the field. It sheds light on the impact of different level of education, fields of study and professional background on air quality, offering valuable insights for understanding the link between leaders' backgrounds and their countries' clean air policies performances. It also provides a new decision-making tool for voters, donors and parliamentarians.

Literature review

Case study: The success of Costa Rica's environmental policies

Brazil is a developing country with the distinction of being home to the world's largest rainforest, the Amazon. Nevertheless, during the tenure of Jair Bolsonaro (2019-2022) as president, there has been a notable increase in deforestation. President Jair Bolsonaro appointed Ricardo Salles, an advocate of natural resource exploitation, as the country's environment minister (The Guardian, 2019). In 2020, the government implemented a 25% reduction in the budget of Brazil's environmental agency, the Brazilian Institute of Environment and Renewable Natural Resources (Ibama) (BBC, 2020). President Bolsonaro enacted a decree that permits mining activities within indigenous reserves and national parks (Le Monde, 2020).

Consequently, the rate of deforestation in the Amazonian region increased by 34% in 2020 in comparison to the preceding year (INPE, 2020). There was an 85% increase in the incidence of forest fires in 2019 compared to the previous year (INPE, 2019). The prevalence of mining and deforestation has led to an increase in air and water pollution in the regions concerned (HRW, 2020). The potential causes of failure are numerous and varied. The government's environmental policy has been shaped by the economic interests of extractive industries (The Economist, 2020). The lack of robust environmental institutions and pervasive corruption have hindered the effective implementation of environmental legislation (Transparency International, 2020).

Furthermore, there is a dearth of citizen participation and public consultation in the development of environmental policies (Amnesty International, 2020). This case study demonstrates that environmental policies may fail when economic interests exert undue influence and when there is a dearth of citizen participation and public consultation.

The practice of land clearing through slash-and-burn agriculture or shifting cultivation results in the release of stored CO_2 into the atmosphere. This process generates a substantial quantity of carbon dioxide, amounting to 20% of global fossil fuel emissions. Consequently, deforestation represents the second most significant contributor to global warming. Additionally, it results in the annual degradation of approximately 12 million hectares of fertile land and the loss of thousands of species. Estimates of the latter vary between 8,000 and 28,000 per year (Contreras-Hermosilla, 2000).

It is imperative that political leaders adopt an integrated approach that considers the environmental, social and economic impacts of their decisions. This necessitates the establishment of robust governance structures, the development of resilient institutions and the encouragement of active citizen participation. Furthermore, leaders must be prepared to take decisive action to combat climate change, protect biodiversity and promote sustainable practices.

Case study: The failure of Brazil's environmental policies

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of active citizen participation. Furthermore, leaders must be prepared to take decisive action to combat climate change, protect biodiversity and promote sustainable practices.

Empirical approach and data

Explanatory variable of Interest

The compilation of data concerning the profiles of political leaders is grounded in the Archigos and Goemans, Gleditsch and Chiozza (2009) database. The collection of data was conducted on a sample of 189 political leaders who presided over 55 developing countries spanning from 1995 to 2018 with a colonial and natural resource-producing background. This is a selection of African, Latin American, Central and South Asian countries. The choice of the estimation period as well as that of the countries is guided by the availability of data.

Two main pieces of information were identified: the leader's level of education and the associated field of study. The leader's level of education ("level") was inspired by Besley et al. (2013). This variable is discrete and takes values from 1 to 8 "Unknown (no information); Literate (no formal education); Elementary school/primary school/primary school or tutor; High school/ graduate school/secondary school/vocational school; Special education (beyond high school) e.g., Mechanical, nursing, art, music, or military school; University; Graduate or professional school (e. g. Master's degree); Doctorate (e. g. Ph.D.)".From this variable, Besley et al. (2013) generate another to identify "highly educated leaders"(HEL) or postgraduate. It takes the value 1 if the level of education is 7 or above, and 0 if it is below. We also generate the variable "College" corresponding to university. Figure 1 below shows the distribution of African leaders by level of education.

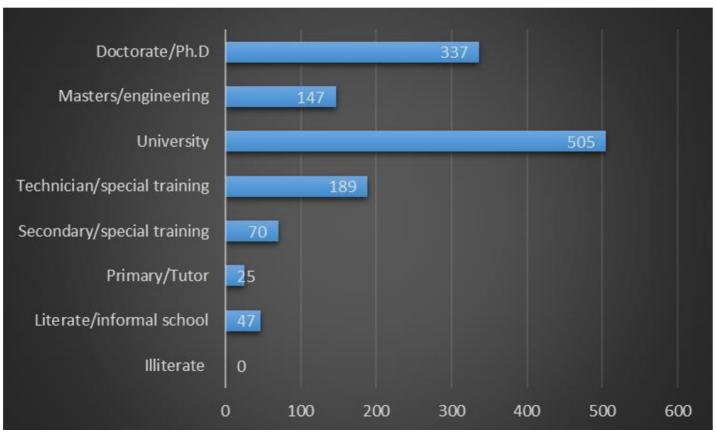

Fig. 1. leaders by level of education
Source: Authors compilation
Рис. 1. Лидеры по уровню образования
Источник: подборка авторов

The field of studies variables is derived from the research of Gölhmann and Vaubel (2007) and Dreher et al. (2009). The leaders are categorized into four fields of study: economics, law/political science, Human sciences, sciences/engineering (see Figure 2). If an incumbent has completed multiple courses, the one that resulted in the highest degree is considered, and the corresponding field of study is associated with the level of education attained.

The second set of explanatory variables of interest pertains to environmental policies. These core explanatory variables refer to the effect of regulatory activity measured in terms of clean air policy density (Policy density) and intensity (Policy intensity). In general, it is expected that

emission intensities will decrease with denser and more intense clean air regulations, and vice versa.

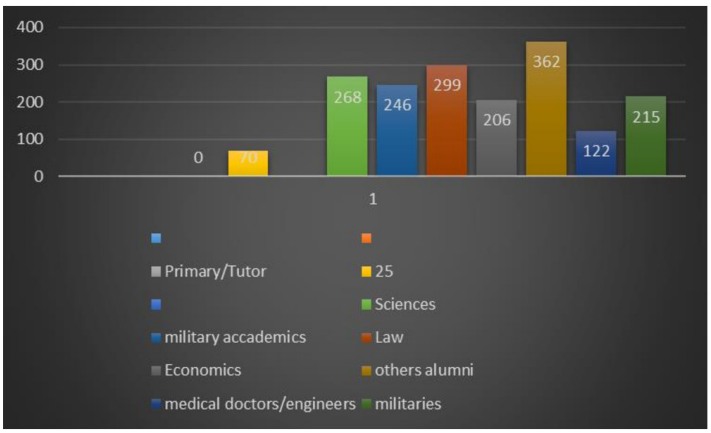

Fig. 2. Leaders field of studies and profession
Source: Author compilation
Рис. 2. Область обучения и профессия лидеров
Источник: составлено автором

Dependent variable: measuring environment quality

The main measure of environmental quality has for a very long time been the volume of CO2 emissions (Panayotou, 2003; Xepapadeas, 2005; Avom and al, 2020; Fotio, 2023).

It is, however, important to note that the assessment of environmental quality cannot be based on a single indicator.

In this essay, it will be a question of estimating the effects of leader's profile and environmental policy on some indicators of environmental quality, namely: Carbone dioxide (CO2), methane (CH4), nitrous oxide (N2O), ammonia (NH4), Non-Methane Volatile Organic Compounds (NMVOC), Nitrogen oxides (NOx), Fine Particulate Matter (PM10 and PM2.5 and Carbonaceous speciation (BC, OC) and total greenhouse gas (GHG). The description of these variables are presented in table 1 of the appendix.

Although in principle there should be a relationship between actual decisions taken by governments (i.e., policy outputs) and changes in environmental quality (i.e., policy impacts), this relationship may be influenced by a large number of additional variables (see Neumayer 2002). It is therefore a challenging task to estimate the net effect of government decisions on changes in environmental quality using control variables. For example, the level of carbon dioxide emissions in a country may depend not only on economic booms and busts – a popular control variable but also on a number of additional structural variables, such as the technological progress, urbanisation and trade openness (see, for example, Aubourg et al. 2008).

Table 1. **Variable description**
Таблица 1. **Описание переменных**

Code	Variable	Description	Source
ccl_nlegl	Number of climate change laws	The term denotes the collective total of all legislative acts (e.g. acts, laws, decree-laws) pertaining to climate change, enacted by a parliament or an equivalent legislative authority.	Povitkina, M., Alvarado Pachon, N., & Dalli, C. M. (2021). The quality of government environmental indicators dataset, version sep21. *University of Gothenburg: The Quality of Government Institute, https://www. gu. se/en/quality-government*.
ccl_nexep	Number of climate change policies/ executive provisions	The term refers to the totality of climate change-related policies or other executive provisions, including presidential decrees, executive orders, regulations, government policies, strategies, or plans, that have been published or decreed by the government, president, or an equivalent executive authority.	Povitkina, M., Alvarado Pachon, N., & Dalli, C. M. (2021). The quality of government environmental indicators dataset, version sep21. *University of Gothenburg: The Quality of Government Institute, https://www. gu. se/en/quality-government*.
ccl_mitlpp	Climate change mitigation law or policy in place	The number of legislative acts or executive provisions pertaining to climate change mitigation that are adopted on an annual basis.	Povitkina, M., Alvarado Pachon, N., & Dalli, C. M. (2021). The quality of government environmental indicators dataset, version sep21. *University of Gothenburg: The Quality of Government Institute, https://www. gu. se/en/quality-government*.
ccl_lpp	Climate change law or policy in place	The number of legislative acts and executive provisions adopted on an annual basis with the objective of addressing climate change.	Povitkina, M., Alvarado Pachon, N., & Dalli, C. M. (2021). The quality of government environmental indicators dataset, version sep21. *University of Gothenburg: The Quality of Government Institute, https://www. gu. se/en/quality-government*.
ccl_exepp	Climate change policy/executive provision in place	The number of policies or other executive provisions related to climate change, including presidential decrees, executive orders, regulations, government policies, strategies, or plans, that were published or decreed by the government, president, or equivalent executive authority in the recorded year.	Povitkina, M., Alvarado Pachon, N., & Dalli, C. M. (2021). The quality of government environmental indicators dataset, version sep21. *University of Gothenburg: The Quality of Government Institute, https://www. gu. se/en/quality-government*.
bti_envc	Environmental considerations have been integrated into the process.	This is an expert response to the question of to what extent environmental concerns are effectively taken into account.	Povitkina, M., Alvarado Pachon, N., & Dalli, C. M. (2021). The quality of government environmental indicators dataset, version sep21. *University of Gothenburg: The Quality of Government Institute, https://www. gu. se/en/quality-government*.
ccl_nmitlp	The number of legislative measures designed to mitigate the effects of climate change.	This is a cumulative account of the legislative acts and executive provisions pertaining to climate change mitigation.	*University of Gothenburg: The Quality of Government Institute, https://www. gu. se/en/quality-government*.

Source: Authors compilation.
Источник: подборка авторов

Table 2. **Descriptive statistics**
Таблица 2. **Описательная статистика**

Variable	Obs	Mean	Std. Dev.	Min	Max
edgar co2ti	1320	275.197	1062.731	.84	11157.071
edgar ch4i	1320	3846.839	8600.595	-63.199	62790.362
edgar n2oi	1320	84.171	197.506	1.045	1456.027
edgar nh3i	1320	520.648	1355.281	7.916	10195.605
edgar nmvoci	1320	1475.477	3721.508	-33.756	33153.504
edgar noxi	1320	974.439	3053.79	-91.386	27117.412
edgar oci	1320	150.511	416.47	-.323	2965.32
edgar pm10i	1320	740.983	2257.97	1.365	17040.646
edgar pm25i	1320	455.531	1486.589	.57	11792.282
edgar so2i	1320	1086.217	3835.988	-109.667	33052.25
TotalGHG	1320	375367.97	1221140.8	5650	12355240
Ouv	1320	71.611	34.192	15.636	220.407
Urban	1320	38608126	94676632	485316	8.298e+08
Techn	1320	43155753	1.431e+08	0	1.649e+09
ccl nlegli	1320	2.196	2.493	-6	13
ccl nexepi	1320	2.436	4.095	-19	25
ccl mitlppi	1320	1.733	4.974	-1	64
ccl lppi	1320	2.294	6.159	-2	80
ccl exeppi	1320	1.185	3.424	0	32
bti envci	1320	4.794	2.26	-6.25	19.25
ccl nmitlpi	1320	3.553	4.228	-6	27

Source: Authors compilation
Источник: подборка авторов

Econometric strategy and model

The aim of this article is to assess the effects of leaders' academic background on their country's economic growth. To achieve this, we estimate leaders fixed effects by employing the model inspired from Bertrand and Schoar (2003). They model company performance as a function of managerial capability, company characteristics and manager characteristics. However, it assumes that managerial ability is unobserved but correlated with the observable characteristics of the manager. In this study, companies are substituted by countries and CEOs by presidents. Consequently, the mobility of political leaders is constrained in comparison to that of CEOs in the corporate sector. A president can only serve in a single country for the duration of their term, which introduces a fixed country effect that is distinct from that of political leaders. The model is label as follow:

$$\mathbf{\Delta Y_{ilt} = \lambda_i + \beta_t + \mu_l + Z_{ilt} + \varepsilon_{ilt}} \quad (1)$$

With ΔY_{ilt} representing one of the previous environmental variables in country i at time t when leader l is in power, λ_i β_t μ_l are respectively country, time and leaders fixed effects. Z_{ilt} is the matrix of control variables or covariates describe in table (1). while ε_{ilt} represents the error, term related to each period.

Besley et al. (2011) use a similar model. The fundamental difference between this model and that of Besley et al. (2011) lies in the nature of μl. For Besley et al. (2011), μl is the five years' average growth difference of the period before and after the death from natural causes of a political leader. In their studies, Jones and Oklen (2005) and Besley et al. (2011) employ

a sample comprising political leaders who have died or been compelled to relinquish their posts due to illness, accident, or other natural causes. The objective is to randomize the length of time that each leader was in power. However, in the context of our sample, only 40 leaders have thus far been identified who meet the sampling criterion. However, due to the absence of data over a long period and the recent deaths of leaders such as John Magufuli of Tanzania and Nkurunziza of Burundi, the sample size available for evaluation is considerably reduced. To address this issue, we employ a longitudinal panel design, which expands the sample size and enables us to track changes in the executive's effect on an annual basis throughout their tenure. The validation of the sample in this study may be open to question. Nevertheless, the sample is deemed to be valid for two reasons:

– In the period following independence, the overwhelming majority of young African constitutions did not include an article limiting the number of presidential terms.

– In the wake of the structural adjustment programs that precipitated the wave of democratization in the 1990s, a significant number of countries adopted new constitutions that imposed restrictions on the number of years, terms of office or even presidential age. However, compliance with these constitutions has remained a taboo subject for many leaders, and there has been a resurgence of military regimes that are sometimes acclaimed by the crowds.

In the light of the above, the length of time in power is assumed to be random in the context of this study.

Following the international community's prohibition of military involvement in African politics in the 1990s, numerous military personnel, upon the conclusion of their initial tenure, pursued political careers with the objective of reclaiming power. This phenomenon is exemplified by the cases of some African leaders including Presidents Muhammadu Buhari and Olusegun Obasanjo of Nigeria; President Denis Sassou Nguesso of the Congo; and Mathieu KéréKou of Benin, who sought and secured subsequent terms in office. A considerable number of civilians and former military personnel, either due to circumstances of transition or as a result of being constitutionally elected, have returned to power following their defeat in elections held at the conclusion of their initial term. Examples of this include Joao Bernardo Vieira of Guinea-Bissau and Azali Assoumani of Comoros. This enables us to ascertain the influence of leaders' educational background on economic growth during their initial and subsequent mandates, while taking into account the discontinuity in their term of office. The election defeat and subsequent return to power create distinct before-and-after periods, which are conducive to the DiD approach. The discontinuity in the leader's tenure provides a natural experiment, which DiD can leverage to estimate the causal effect. The use of DiD is to exploit the discontinuity in leaders' term of office, particularly when he or she loses power and returns for a second mandate.

With respect to the PSM, it has the potential to account for cross-sectional variation in leaders' educational background, address selection bias by ensuring that the estimated effect isn't driven by observable differences between leaders with different educational backgrounds through matching and provide a robust framework for causal inference.

This results in two models to be estimated:

– The DiD equation

In this analysis, we use an extended DiD equation inspired from Ashenfelter and Card, (1984). It can be presented as follow:

$$\Delta Y_{it} = \alpha + \beta leaders_i + \gamma POST + \delta(leaders_i * POST) + \mu_i + \theta X_{it} + \lambda_t + \varepsilon_{it} \quad (2)$$

Where Y_{it} represents emissions per tones metrics of country i when leader l is in power at time t. α is the intercept

The variable «$leaders_i$» is used to indicate whether unit i is in the treatment group (coded as 1) or the control group (coded as 0). In this context, the treatment groups include former postgraduate students (HEL), college students, leaders with low levels of education or from non-university backgrounds (LEL or NU), students of economics, law and political sciences, science students and those who have undergone special training.

POST: The POST variable is also binary in nature, denoting whether the specified time period (t) occurs subsequent to the leader's assumption of office (POST=1) or prior to this event (POST=0). In particular, the POST variable is employed to ascertain the impact of the leader's level of education on economic growth during their term of office, in comparison with the preceding period.

The β parameter represents the effect of being in the treatment group (in comparison to the control group), while γ represents the effect of being in the post-treatment period (in comparison to the pre-treatment period).

The term 'δ' is used to denote the 'difference in difference' estimate, which represents the effect of the treatments(leaders) on the outcome variable (emissions).

Xit is a vector of control variables, including technological progress (mobile phone subscribers), trade openness (trade) and urbanisation (Urban).

μi represents a country-specific fixed effect, capturing unobserved heterogeneity across countries. λt denotes a time-specific fixed effect, capturing unobserved heterogeneity across time periods. Finally, εit represents the error term.

– The PSM equation

In order to facilitate a comparison with Model (2), this study examines an enhanced version of the PSM equation that incorporates the attributes of the DiD method proposed by Heckman et al. (1997).

$$\mathbf{\Delta Y_{it} = \alpha + \beta leaders_i + \gamma POST + \delta(leaders_i * POST) + \theta PS_{it} + \mu_i + \Gamma X_{it} + \lambda_t + \varepsilon_{it}} \quad (3)$$

The propensity score (PSit) represents the predicted probability of being in the treatment group (i.e., having a highly educated leader for example in power) for unit i at time t, given the observed covariates Xit. Introducing the Propensity Score is for 3 purposes:

The issue of selection bias is a significant one in this context. PSit is designed to control for selection bias by accounting for the probability of a head of state being in the treatment group (postgraduate for example) based on observed characteristics.

It was observed that there was heterogeneity present. PSit is a statistical tool that allows for the examination of observed differences in leaders' characteristics that may affect the outcome variable, namely economic growth.

The PSit method is employed to identify leaders with analogous characteristics, thereby facilitating a more robust estimation of the treatment effect, defined as the impact of leaders' educational background on economic growth.

The POST variable allows the influence of political context to be isolated and growth trends to be accounted for prior to the leader assuming office. To be more precise, the POST variable is employed to estimate the causal effect of the leader's level of education on economic growth, independently of other factors and to control for pre-existing trends or differences in economic growth prior to the leader taking office.

Results and discussion

Non-parametric approach: The graphical approach

Graphical method has historically been an integral part of data analysis. It makes it possible to observe the evolution of variables over time in order to make comparisons. Biscotti and D'Amico (2016) posit that cognitive and motivational factors exert a predominant influence on

the environmental intentions of political leaders, whereas the external context exerts a negligible effect. Political leaders who are younger tend to demonstrate a greater proclivity towards environmentalism than those who are older. To verify this assertion in the context of developing countries, we focus on leader's educational background. It is necessary to observe the CO_2 curve of highly educated leaders (HEL) and compared it to that of leaders with college background and low educated leaders. Figure 3.3 below indicates that, leaders educational background do not really matters.

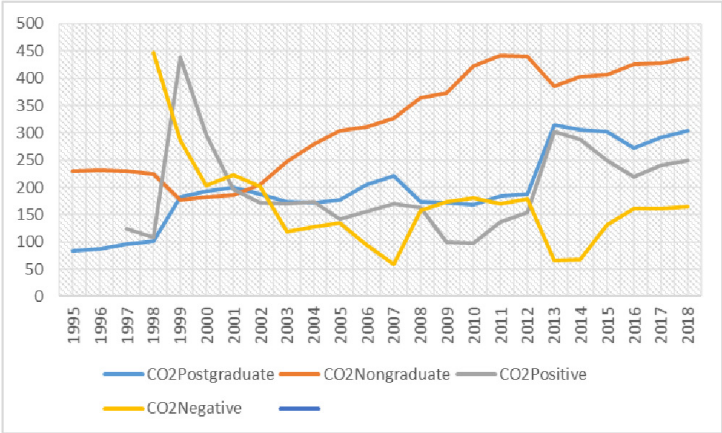

Fig. 3. Comparative CO2 emission
Source: Authors compilation
Рис. 3. Сравнительный выброс CO2
Источник: подборка авторов

Although this approach may seem intuitive (Easterly and Pennings, 2020**)**, it is important because it allows for the expression of raw variables without incorporating any econometric assumptions.

Parametric analysis

Results of the Two-Stage Residuals Regression approach

Leaders' fixe effect is relevant for two reasons: the inclusion of leader fixed effects in the model allows for the accounting of time-invariant leader characteristics that may influence the environment, while simultaneously providing estimates of leader-specific effects. This approach enables the estimation of the individual leader's impact on the outcome variable, while controlling for other factors. It also accounts for heterogeneity which captures leader-specific heterogeneity, which is defined as the variation in leader effects across leaders.

Table 3. **Postgraduates and environmental quality: Bertrand and Schoar (2003) approach**
Таблица 3. **Аспиранты и качество окружающей среды: подход Бертрана и Шоара (2003)**

	(Postgraduate)	(Postgraduate)	(Postgraduate)	(Postgraduate)	(Postgraduate)	(Postgraduate)	(Postgraduate)	(Postgraduate)	(Postgraduate)	(Postgraduate)
VARIABLES	logCO2	logCH4	logN2O	logNH3	logNMVOCI	logNOXI	logOCI	logPM10	logPM25	logSO2
1.leader_id	-0.0106	0.00551	0.0191	-0.00315	-0.0440	-0.0233	-0.0233	0.00799	-0.00475	0.0491
	(0.0544)	(0.0322)	(0.0273)	(0.0272)	(0.0268)	(0.0470)	(0.0470)	(0.0404)	(0.0395)	(0.105)
Ouv	-0.000664	-0.00144**	-0.000406	-0.000400	-0.00189**	-0.00110*	-0.00110*	0.000130	-0.000292	-0.00133
	(0.000707)	(0.000640)	(0.000277)	(0.000311)	(0.000775)	(0.000612)	(0.000612)	(0.000513)	(0.000698)	(0.00107)
Urban	1.89e-09*	3.79e-10	3.34e-10	4.15e-10	1.39e-09**	1.64e-09	1.64e-09	4.87e-10	8.96e-10	1.39e-09
	(9.74e-10)	(4.55e-10)	(4.60e-10)	(6.82e-10)	(5.23e-10)	(9.85e-10)	(9.85e-10)	(8.42e-10)	(9.61e-10)	(1.22e-09)
Techn	-2.36e-10	-9.13e-11	-7.87e-11	-1.35e-10	-1.75e-10	-2.03e-10	-2.03e-10	-1.84e-10	-2.39e-10	-7.68e-11
	(2.43e-10)	(9.92e-11)	(1.01e-10)	(1.51e-10)	(1.43e-10)	(2.59e-10)	(2.59e-10)	(2.16e-10)	(2.54e-10)	(3.14e-10)
ccl_nlegli	-0.0155	-0.0202**	-0.0104*	-0.0159**	-0.00177	-0.00423	-0.00423	-0.0191	-0.0111	0.0233
	(0.0130)	(0.00879)	(0.00584)	(0.00789)	(0.0108)	(0.0111)	(0.0111)	(0.0120)	(0.0126)	(0.0237)
ccl_nexepi	0.0158*	-0.00819	-0.00148	-0.00668	0.00685	0.0172**	0.0172**	-0.0114	-0.00573	0.0283
	(0.00901)	(0.00517)	(0.00304)	(0.00660)	(0.00859)	(0.00832)	(0.00832)	(0.00812)	(0.00800)	(0.0174)
ccl_mitlppi	-0.000339	0.00392	-0.00601	-0.00366	0.0151**	-2.85e-05	-2.85e-05	-0.00535	-0.00568	-0.00698
	(0.0101)	(0.00684)	(0.00400)	(0.00359)	(0.00728)	(0.00652)	(0.00652)	(0.00849)	(0.00922)	(0.0195)
ccl_lppi	-0.00115	-0.00531	0.00504	0.00241	-0.0156**	-0.00107	-0.00107	0.00188	0.00273	-0.00189
	(0.00962)	(0.00610)	(0.00368)	(0.00335)	(0.00726)	(0.00548)	(0.00548)	(0.00780)	(0.00864)	(0.0152)
ccl_exeppi	0.00100	0.00513	-0.00226	-0.000281	0.00423	-0.00296	-0.00296	0.00283	0.000364	-0.00439
	(0.00734)	(0.00428)	(0.00190)	(0.00211)	(0.00550)	(0.00452)	(0.00452)	(0.00599)	(0.00621)	(0.0104)
bti_envci	-0.00901	-0.000668	0.00188	-0.00227	-0.0177***	-0.0103*	-0.0103*	-0.00447	-0.00698**	-0.0292**
	(0.00777)	(0.00657)	(0.00291)	(0.00326)	(0.00367)	(0.00541)	(0.00541)	(0.00365)	(0.00344)	(0.0109)
ccl_nmitlpi	-0.00729	0.0117	0.00388	0.0112	-0.00334	-0.00972	-0.00972	0.0147	0.0117	-0.0185
	(0.0114)	(0.00713)	(0.00398)	(0.00794)	(0.00969)	(0.00940)	(0.00940)	(0.00918)	(0.00890)	(0.0198)
Constant	1.626***	3.542***	1.523***	2.407***	3.113***	2.589***	2.589***	2.321***	2.076***	2.667***
	(0.0515)	(0.0428)	(0.0287)	(0.0341)	(0.0594)	(0.0514)	(0.0514)	(0.0454)	(0.0572)	(0.0906)
Observations	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320
R-squared	0.641	0.382	0.553	0.552	0.458	0.478	0.478	0.418	0.351	0.152
Number of Codepays	55	55	55	55	55	55	55	55	55	55

Source: Authors compilation **Note:** Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5% and 10%.

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This model allows for an understanding of the extent to which leaders differ from each other. Furthermore, it provides insight into leader-specific traits, whereby the estimation of heterogeneity in leader's effects enables the inference of the importance of leader-specific traits (e.g. ability, style) in explaining emissions.

In accordance with the approach set forth by Serrano and Pérez (2011), Table 3.4 considers the transitions in the education level of leaders. Accordingly, the positive transition is defined by the binary variable, which assumes the value of 1 when a higher-level leader assumes the role of a lower-level leader and 0 otherwise. Similarly, the negative transition variable is assigned a value of 1 if a lower-level leader succeeds a higher-level leader, and 0 if not.

The results presented in Tables 3 and 4 indicate that the impact of the leader's educational background is not a significant factor in the environment. Nevertheless, it is evident that the policy pursued by the leader is the factor that matters.

Results of the Difference in Difference and PSM approach

Education can be regarded as an indicator of a person's knowledge, skill base, cognitive ability and leadership potential. The level of education (i.e., the number of years spent in formal schooling), the type of education (mainly an MBA degree or other qualifications), and the quality of education (the university's prestige) are the most important indicators of a leader's educational background. These factors have been linked to organizational performance (You and al., 2020).

Table 4. **Leaders education transition and environmental quality: Bertrand and Schoar (2003) approach**
Таблица 4. **Переход к образованию лидеров и качество окружающей среды: подход Бертрана и Шоара (2003)**

VARIABLES	(Postive) logCO2	(Postive) logCH4	(Postive) logN2O	(Postive) logNH3	(Postive) logNMVOCI	(Postive) logNOXI	(Postive) logOCI	(Postive) logPM10	(Postive) logPM25	(Postive) logSO2	(Postive) logGHG
1.leader_id	0.0165	-0.0431	-0.0157	0.00144	0.00740	-0.0568	-0.0568	0.00862	-0.0805	0.0569	0.00368
	(0.0660)	(0.0838)	(0.0247)	(0.0274)	(0.0686)	(0.0691)	(0.0691)	(0.0666)	(0.112)	(0.0964)	(0.0266)
Trade	-0.000747	-0.00139**	-0.000350	-0.000382	-0.00197**	-0.00106*	-0.00106*	0.000132	-0.000257	-0.00121	-0.000448
	(0.000688)	(0.000619)	(0.000293)	(0.000326)	(0.000751)	(0.000611)	(0.000611)	(0.000499)	(0.000665)	(0.00110)	(0.000487)
Urban	1.96e-09*	5.15e-10	3.69e-10	4.60e-10	1.44e-09**	1.61e-09	1.61e-09	6.38e-10	1.05e-09	1.46e-09	1.21e-09**
	(1.03e-09)	(4.34e-10)	(4.33e-10)	(6.89e-10)	(5.40e-10)	(1.08e-09)	(1.08e-09)	(8.00e-10)	(9.75e-10)	(1.25e-09)	(4.86e-10)
Techn	-2.57e-10	-1.20e-10	-8.74e-11	-1.46e-10	-1.93e-10	-2.02e-10	-2.02e-10	-2.19e-10	-2.76e-10	-9.39e-11	-8.05e-11
	(2.50e-10)	(9.28e-11)	(9.79e-11)	(1.55e-10)	(1.44e-10)	(2.84e-10)	(2.84e-10)	(2.03e-10)	(2.56e-10)	(3.29e-10)	(1.05e-10)
ccl_nlegli	-0.0144	-0.0200**	-0.0102*	-0.0157*	-0.00119	-0.00506	-0.00506	-0.0184	-0.0114	0.0228	-0.0203***
	(0.0124)	(0.00833)	(0.00577)	(0.00786)	(0.0102)	(0.0110)	(0.0110)	(0.0126)	(0.0133)	(0.0237)	(0.00738)
ccl_nexepi	0.0145*	-0.00943*	-0.00174	-0.00734	0.00582	0.0156*	0.0156*	-0.0124	-0.00731	0.0265	-0.00190
	(0.00841)	(0.00480)	(0.00283)	(0.00672)	(0.00801)	(0.00780)	(0.00780)	(0.00857)	(0.00825)	(0.0177)	(0.00547)
ccl_mitlppi	-0.00292	0.00228	-0.00606	-0.00447	0.0131*	-0.00255	-0.00255	-0.00607	-0.00711	-0.00979	-0.0103**
	(0.0101)	(0.00647)	(0.00372)	(0.00316)	(0.00704)	(0.00681)	(0.00681)	(0.00828)	(0.00900)	(0.0211)	(0.00485)
ccl_lppi	0.000599	-0.00487	0.00478	0.00275	-0.0142**	-0.000255	-0.000255	0.00222	0.00303	-0.00106	0.00659
	(0.00967)	(0.00600)	(0.00353)	(0.00310)	(0.00707)	(0.00582)	(0.00582)	(0.00763)	(0.00845)	(0.0166)	(0.00472)
ccl_exeppi	0.00131	0.00621	-0.00172	0.000150	0.00439	-0.00155	-0.00155	0.00320	0.00141	-0.00258	0.00246
	(0.00752)	(0.00455)	(0.00198)	(0.00212)	(0.00514)	(0.00466)	(0.00466)	(0.00586)	(0.00614)	(0.0106)	(0.00382)
bti_envci	-0.00909	-0.000934	0.00178	-0.00240	-0.0174***	-0.0101*	-0.0101*	-0.00457	-0.00699*	-0.0302**	0.00400
	(0.00776)	(0.00636)	(0.00305)	(0.00337)	(0.00379)	(0.00539)	(0.00539)	(0.00381)	(0.00351)	(0.0114)	(0.00506)
ccl_nmitlpi	-0.00614	0.0129*	0.00429	0.0118	-0.00252	-0.00704	-0.00704	0.0154	0.0138	-0.0149	0.00569
	(0.0109)	(0.00686)	(0.00380)	(0.00801)	(0.00900)	(0.00900)	(0.00900)	(0.00973)	(0.00953)	(0.0202)	(0.00630)
Constant	1.624***	3.539***	1.526***	2.404***	3.097***	2.579***	2.579***	2.319***	2.069***	2.681***	5.543***
	(0.0508)	(0.0381)	(0.0302)	(0.0333)	(0.0579)	(0.0520)	(0.0520)	(0.0469)	(0.0574)	(0.0962)	(0.0509)
Observations	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320	1,320
R-squared	0.634	0.374	0.552	0.546	0.452	0.474	0.474	0.416	0.349	0.137	0.684
Number of Codepays	55	55	55	55	55	55	55	55	55	55	55

Source: Authors compilation. **Note:** Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5% and 10%.
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Table 5. **Postgraduate and environmental quality: DiD approach**
Таблица 5. **Качество последипломного образования и окружающей среды: подход DiD**

VARIABLES	(Postgraduate) CO2	(Postgraduate) CO2	(Postgraduate) CO2	(Postgraduate) CO2	(Postgraduate) CO2	(Postgraduate) CO2	(Postgraduate) CO2
DiDestimate	-0.0374***	-0.0359***	-0.0353***	-0.0336***	-0.0374***	-0.0374***	-0.0357***
	(0.00738)	(0.00748)	(0.00759)	(0.00739)	(0.00749)	(0.00729)	(0.00740)
placebo	-0.000993	-0.000758	-0.000829	-0.000867	-0.000414	-0.000284	-0.000887
	(0.00397)	(0.00402)	(0.00400)	(0.00399)	(0.00397)	(0.00403)	(0.00402)
Urban	-1.48e-10	-2.32e-10	-2.34e-10	-2.36e-10	-0	-2.51e-10	-1.63e-10
	(3.34e-10)	(3.48e-10)	(3.42e-10)	(3.39e-10)	(3.63e-10)	(3.50e-10)	(3.58e-10)
Ouv	0.000144	0.000125	0.000150	0.000179	0.000143	0.000151	0.000128
	(0.000144)	(0.000144)	(0.000142)	(0.000143)	(0.000142)	(0.000139)	(0.000145)
Techn	-8.35e-11	-7.90e-11	-7.76e-11	-7.83e-11	-1.36e-10**	-7.28e-11	-9.76e-11
	(6.05e-11)	(6.38e-11)	(6.30e-11)	(6.30e-11)	(6.83e-11)	(6.39e-11)	(6.72e-11)
bti_envci	-0.00557***						
	(0.00119)						
ccl_exeppi		0.000446					
		(0.000851)					
ccl_lppi			-0.00125***				
			(0.000316)				
ccl_mitlppi				-0.00254***			
				(0.000523)			
ccl_nexepi					0.00439***		
					(0.000991)		
ccl_nlegli						-0.00380**	
						(0.00164)	
ccl_nmitlpi							0.00117
							(0.000850)
Constant	0.253***	0.238***	0.246***	0.248***	0.245***	0.234***	0.241***
	(0.0252)	(0.0235)	(0.0242)	(0.0246)	(0.0246)	(0.0247)	(0.0246)
Observations	1,320	1,320	1,320	1,320	1,320	1,320	1,320
R-squared	0.877	0.875	0.875	0.877	0.877	0.875	0.875

Source: Authors compilation. **Note:** Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5% and 10%.

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Table 6. **Negative transition and environmental quality: DiD approach**
Таблица 6. **Отрицательный переход и качество окружающей среды: подход DiD**

VARIABLES	(Negative) CO2	(Negative) CO2	(Negative) CO2	(Negative) CO2	(Negative) CO2	(Negative) CO2	(Negative) CO2
DiDestimate	0.00827**	0.00843**	0.00883**	0.00906**	0.00881**	0.00947**	0.00819**
	(0.00411)	(0.00406)	(0.00412)	(0.00416)	(0.00415)	(0.00397)	(0.00411)
placebo	0.00229	0.00192	0.00221	0.00212	0.00153	0.00175	0.00196
	(0.00395)	(0.00397)	(0.00397)	(0.00394)	(0.00393)	(0.00396)	(0.00398)
Urban	-1.57e-10	-2.34e-10	-2.36e-10	-2.40e-10	-0	-2.51e-10	-1.55e-10
	(3.46e-10)	(3.58e-10)	(3.51e-10)	(3.47e-10)	(3.73e-10)	(3.61e-10)	(3.69e-10)
Ouv	4.74e-05	3.28e-05	6.24e-05	9.90e-05	4.60e-05	5.00e-05	3.68e-05
	(0.000138)	(0.000139)	(0.000138)	(0.000139)	(0.000137)	(0.000136)	(0.000140)
Techn	-7.98e-11	-7.54e-11	-7.38e-11	-7.44e-11	-1.28e-10*	-6.98e-11	-9.69e-11
	(6.33e-11)	(6.62e-11)	(6.54e-11)	(6.53e-11)	(7.05e-11)	(6.65e-11)	(6.99e-11)
bti_envci	-0.00504***						
	(0.00115)						
ccl_exeppi		0.000428					
		(0.000893)					
ccl_lppi			-0.00140***				
			(0.000297)				
ccl_mitlppi				-0.00288***			
				(0.000532)			
ccl_nexepi					0.00407***		
					(0.000973)		
ccl_nlegli						-0.00307*	
						(0.00172)	
ccl_nmitlpi							0.00133
							(0.000872)
Constant	0.227***	0.214***	0.223***	0.227***	0.220***	0.210***	0.218***
	(0.0234)	(0.0218)	(0.0222)	(0.0225)	(0.0227)	(0.0226)	(0.0226)
Observations	1,320	1,320	1,320	1,320	1,320	1,320	1,320
R-squared	0.872	0.871	0.871	0.873	0.873	0.871	0.871

Source: Authors compilation. **Note:** Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5% and 10%.

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Table 7. **Leaders educational and professional background effects on CO2 emissions: PSM approach**
Таблица 7. **Влияние образовательного и профессионального опыта лидеров на выбросы CO2: подход PSM**

VARIABLES	(postgraduate) CO2	(positive) CO2	(Negative) CO2	(Business) CO2	(Lawyers) CO2	(Politics) CO2	(Militaries) CO2
ATE	-0.0491***	-0.0352***	0.0358	-0.0429**	-0.0316**	-0.0204*	0.0473***
(1 vs 0)	(0.0107)	(0.0103)	(0.232)	(0.0171)	(0.0136)	(0.0108)	(0.0157)
Observations	1,320	1,320	1,320	1,320	1,320	1,320	1,320

Source: Authors compilation. **Note:** Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5%

Источник: подборка авторов. **Примечание:** в скобках указаны надежные стандартные ошибки. (***, **, *) указывают на статистическую значимость на уровне 1%, 5%

The data presented in Tables 5 and 7 indicate that there is a negative and significant effect of highly educated leaders on CO_2 emissions. However, a transition in a country from a low to a highly educated leader does not significantly impact air quality (see table 8 in Appendix). Conversely, a negative transition is accompanied by an increase of approximately 0.8% in air pollution. This suggests that the environmental performance of a country is, to some extent, attributable to the presence of political leaders, rather than being a mere consequence of chance, as previously described by Berry and Fowler (2021).

Furthermore, Tables 5, 6 and 8 in the appendix illustrates the placebo coefficient, representing the impact of the fictitious treatment (placebo) on air quality. The insignificant placebo coefficient suggests that the fictitious treatment does not exert a considerable influence on CO2 emissions, thus reinforcing the soundness of the DiD design.

Conclusion and implications

The objective of this study was to determine the impact of presidential professional profiles on CO^2 emissions. It is understood that the majority of studies examining the determinants of pollution have consistently prioritized economic, structural, institutional, and political factors, while seldom considering the individual characteristics of presidents. In line with extant literature on political leaders, this chapter has identified a new determinant specific to the economies of developing countries: the professional and academic background of heads of state.

A body of research in the social sciences, particularly in psychology and sociology, has demonstrated that experiences such as studying abroad, socio-economic status (Hayo and Florian Neumeier, 2011), and professional status (Dreher et al., 2009) can influence individuals' preferences and define their performance. The present study hypothesizes that education is strongly associated with income, skills, civic engagement, and leadership quality. This study aims to contribute to the existing literature by examining the impact of leaders' educational backgrounds on their environmental performance. To this end, we employed the adaptive improved growth model developed by Bertrand and Schoar (2003), leveraging four estimation methods: a graphical approach, a two-stage residuals regression approach, a difference-in-difference approach, and a propensity score matching approach. The results from the leader's educational and professional background show global variations from the estimation techniques. However, the results from environmental policies remain consistent. The findings of the present study indicate that, despite the cognizance of environmental challenges exhibited by highly educated leaders, the implementation of contingency measures is the sole means of achieving a substantial reduction in pollution levels.

Table 8. **Positive transition and environmental quality: DiD approach**

Таблица 8. **Положительный переход и качество окружающей среды: подход DiD**

VARIABLES	(Positive) CO2	(Positive) CO2	(Positive) CO2	(Positive) CO2	(Positive) CO2	(Positive) CO2	(Positive) CO2
DiDestimate	-0.000698	0.00144	-0.000436	-0.00114	0.00272	-0.000329	0.00193
	(0.00589)	(0.00572)	(0.00585)	(0.00604)	(0.00582)	(0.00566)	(0.00584)
placebo	0.000892	0.000345	0.000261	3.31e-05	7.40e-05	-7.23e-05	0.000472
	(0.00388)	(0.00391)	(0.00389)	(0.00386)	(0.00388)	(0.00391)	(0.00390)
Urban	-1.52e-10	-2.21e-10	-2.29e-10	-2.33e-10	-0	-2.41e-10	-1.37e-10
	(3.49e-10)	(3.62e-10)	(3.55e-10)	(3.52e-10)	(3.76e-10)	(3.65e-10)	(3.72e-10)
Ouv	5.74e-05	4.11e-05	7.34e-05	0.000112	5.37e-05	6.17e-05	4.42e-05
	(0.000140)	(0.000140)	(0.000139)	(0.000140)	(0.000138)	(0.000137)	(0.000141)
Techn	-8.31e-11	-8.09e-11	-7.79e-11	-7.82e-11	-1.35e-10*	-7.49e-11	-1.04e-10
	(6.45e-11)	(6.72e-11)	(6.65e-11)	(6.65e-11)	(7.12e-11)	(6.76e-11)	(7.07e-11)
bti_envci	-0.00507***						
	(0.00115)						
ccl_exeppi		0.000498					
		(0.000875)					
ccl_lppi			-0.00139***				
			(0.000281)				
ccl_mitlppi				-0.00287***			
				(0.000543)			
ccl_nexepi					0.00409***		
					(0.000958)		
ccl_nlegli						-0.00294*	
						(0.00168)	
ccl_nmitlpi							0.00141*
							(0.000855)
Constant	0.227***	0.215***	0.223***	0.227***	0.222***	0.211***	0.219***
	(0.0235)	(0.0221)	(0.0224)	(0.0225)	(0.0229)	(0.0226)	(0.0227)
Observations	1,320	1,320	1,320	1,320	1,320	1,320	1,320
R-squared	0.872	0.870	0.871	0.873	0.872	0.871	0.871

Source: Authors compilation. **Note:** Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5%.

Источник: подборка авторов. **Примечание:** в скобках указаны надежные стандартные ошибки. (***, **, *) указывают на статистическую значимость на уровне 1%, 5%.

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Authors' contribution

F.L.T. Nono – collection and primary processing of data, development of the concept, writing of the article, data analysis and description of results. preparation, creation of the published work, specifically writing the initial draft, presentation, creation and presentation of the published work – including pre-or postpublication stages.

J.H. Nlom – management activities to annotate, scrub data, and maintain research for initial use and later reuse, oversight and leadership responsibility for the research activity planning and execution.

Conflict of interests

One of the authors, Pr Jean Hugues Nlom is a member of the editorial board of "Economy and nature management in the North". The authors are not aware of any other potential conflict of interest relating to this article.

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