The Nexus between the Length of Colonization and Access to Electricity in 126 countries Around the World

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Abstract

The percentage of the population with access to electricity varies considerably from one country to another. This study examines the extent to which the percentage of a country's population with access to electricity is affected by the length of time it has been under colonial rule. To do this, the study employs Ordinary and Two-Stage Least Squares estimation techniques with data from 126 countries around the world. The results show that people living in countries that have been under colonial rule for a long time are more likely to have better access to electricity. This is partly explained by high levels of political stability and education, but also by low population growth in these countries. Therefore, to guarantee access to electricity for a larger proportion of the population, countries that have experienced shorter periods of colonization need to implement policies that not only promote political stability and education but also slow down population growth.

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1. Introduction

What fundamentally explains the international differences in access to electricity? This is the question that our study sets out to answer. Access to electricity is crucial to a country's economic success. As documented by Alegre-Bravo and Lindsay-Anderson (2023), access to electricity plays a fundamental role in sustainable development by facilitating the provision of basic services (clean sanitation and healthcare, as well as efficient lighting, cooling, cooking, use of mechanical power transformation, and telecommunication services) and improving the quality of life for the population. Access to modern and affordable electricity services is therefore an essential condition for eradicating poverty. This is no doubt why the United Nations (2015) included achieving universal access to affordable, reliable, sustainable, and modern energy as a Sustainable Development Goal in its 2030 agenda. Given the importance of access to electricity, several studies (Noumba and Nguea, 2023; Totouom, 2023; Ahlborg et al., 2015) have been carried out to determine the factors behind it. Among these factors, particular interest seems to be focused on oil rents, institutional quality, financial globalization, trade openness, and foreign direct investment. Noumba and Nguea (2023) for example found that financial globalization, foreign direct investment, and trade openness increase access to electricity. Totouom (2023), however, has shown that oil rents increase urban-rural disparities in access to electricity. Ahlborg et al. (2015) for their part found that good institutional quality enhances access to electricity.

This literature is certainly interesting, but it completely ignores the role of the temporal dimension of colonization, given that most countries in history have experienced a period of colonization. Moreover, not all countries that have experienced colonization have the same development profile. This leaves an important gap in research. To fill this gap, we examine the effect of the duration of colonization on access to electricity. Indeed, the paper hypothesizes that countries that experienced longer colonial periods have better access to electricity than countries where the colonial periods were brief. To the best of our knowledge, this possibility has not previously been studied.

There is, however, a large amount of literature on the long-term economic effects of the duration of colonization, but it is much more concerned with economic growth, income, democracy, and development (Grier, 1999; Ertan and Putterman,2008; Olsson, 2009). The theoretical underpinning of the hypothesized relationship between colonial duration and access to electricity is easy to appreciate. Indeed, the colonial powers tried to make life as easy as possible for colonial officials and other Europeans in the colonial territories. So, over time, facilities such as electrical infrastructure, designed to make life more pleasant, were put in place. These pieces of infrastructure were left in place with the end of colonialism promoting wider access to electricity in these territories. Therefore, it is reasonable to assume that countries in which the colonial era lasted longer have better access to electricity than their counterparts in which this era was brief. Using a cross-sectional dataset of 126 countries for the period 2000-2021, our study showed that colonial duration improves access to electricity. This finding is robust on the one hand to the inclusion of additional potential variables and remains robust when we consider rural and urban access to electricity. Furthermore, our study also highlights the mediating roles of political stability, education, and population growth.

The rest of the paper is organized as follows: section 2 makes a literature review, section 3 describes the data and methodology, section 4 exposes and discusses the results, and section 5 concludes.

2. The Economic Argument

Theoretically, the link between the duration of colonization and access to electricity is rooted in the literature linking colonialism and development. Although there are other explanations, the general consensus in the literature is that the colonial legacy of energy infrastructure is currently the main channel through which the duration of colonization influences access to electricity. In general, colonies with a longer history of colonization have benefited from greater investment in energy infrastructure (Bestari et al., 2022). These investments were aimed at improving the living conditions of settlers and supporting economic activities (mining, agriculture, and industry) in the colonies (Hirschman, 1958). The colonies that inherited these infrastructures have taken advantage of this substantial investment base to develop their infrastructures today (Easterly and Levine, 2003; Herbst, 2000).

Empirically, our study is part of two strands of the literature: that on the economic outcome effects of colonial duration, and that relating to the determinants of access to electricity.

Concerning the first strand, a close look at the literature shows that the influence of colonial duration on economic outcomes has not been unanimously accepted. Grier (1999), for example, examined the relationship between colonial duration and economic growth for a sample of 63 ex-colonial states between 1961 and 1990. Following econometric estimates, he found that colonies that had been held for longer periods tended to perform better on average after independence. Similarly, Olsson (2009) shows that there is a strong positive effect of colonial duration on democracy. In the same vein, Njoh and Akiwumi (2011) analyzed the relationship between colonial duration and access to improved water and sanitation facilities in Africa. The econometric results obtained by these authors show that access to improved water and sanitation facilities is greater in cities within countries that experienced longer periods of colonization. Unlike previous studies, Maseland (2018) shows that differences in institutional quality or income are explained less by colonial duration. Although this literature is interesting, to the best of our knowledge, there is not yet a study that has looked at the implications of colonial duration in terms of access to electricity, which is essential for the economic and social development of humans (Awaworyi et al., 2022).

Regarding the second strand, the news revolves around determinants such as natural resources, macroeconomic instability, globalization, and the development of digital economy. By way of illustration, Totouom (2023) examined the relationship between oil rents and urban-rural disparity in access to electricity in 36 African countries over the period 2000-2017. Following econometric estimates, this author found that oil rents increase urban-rural disparities in access to electricity. Similarly, Ongo Nkoa et al. (2023) investigated the relationship between natural resources and access to electricity in 45 Sub-Saharan African countries over the period 1997-2018. The econometric results found by these authors show that natural resource-dependent countries in Sub-Saharan Africa have limited access to electricity. Kamguia et al. (2023) for their part analyzed the link between macroeconomic instability and access to electricity in developing countries. Using

the generalized method of moments, these authors found that macroeconomic instability reduces access to electricity in developing countries. In addition, Numba and Nguea (2023) found that economic, social, and political globalization increase access to electricity in Africa. According to these authors, globalization offers technological innovation, financial resources, and international cooperation opportunities to achieve universal electricity access. Furthermore, Wang et al. (2023) found that the development of the digital economy has a positive impact on energy poverty alleviation. Despite this updated literature on the factors that explain access to electricity, to our knowledge, the influence of historical factors such as colonial duration has not yet been highlighted.

3. Methods and Data

3.1 Model Specification

The following econometric model is regressed to investigate how access to electricity is related to colonial duration:

$$Access_i = \alpha + \beta Duration_i + X_i\theta + \varepsilon_i \qquad (1)$$

Where $Access_i$ is access to electricity for country i. Duration denotes a measure of colonial duration. β captures the effect of colonial duration on access to electricity across 126 countries ($i = 1, 2, \ldots, 126$). ε represents the stochastic disturbance term. X_i is a set of geographic, continental, institutional, and economic control variables[1] included in the regression to reduce the possibility of obtaining spurious estimates. One key issue with our empirical strategy is the concern that there might be factors that both affect access to electricity and colonial duration. The vector X_i is included as an attempt to control for such factors. The geographic controls are terrain ruggedness, percentage of tropical climate, and percentage of desert. The continental dummies are Africa, Asia, and South America. Government effectiveness, regulatory quality, and political stability are the institutional variables. Economic and social variables for their part are represented by economic and population growth, respectively. The choice of these control variables is informed by the contemporary literature on the determinants of access to electricity, especially Kamguia et al. (2023), Numba and Nguea (2023), and Totouom (2023).

The parameter we want to identify is β, the effect of colonial duration. The simplest strategy is to estimate the model in equation (1) using ordinary least squares regression. Although this estimation controls for continent fixed effects and several potential confounding factors, the other key issue is the concern that estimating the relationship between colonial duration and access to electricity remains very challenging due to plausible concerns about omitted variable bias and/or measurement error in colonial duration. Furthermore, there could be reverse causation if the prevalence of historically persistent infrastructural underdevelopment could have affected how long colonization lasted. To address these issues, we estimate equation (1) using two-stage least squares with distinct and plausible instruments for colonial duration. Thus, we use population density in 1400 and the dummy variable of Spanish colonization as instruments for colonial duration. The following two arguments can justify the choice of these instruments. Firstly, in the past, densely populated countries were considered to be goldmines in terms of slaves and therefore

[1] Appendix A1 provides detailed descriptions of all variables and data sources.

attracted settlers. Secondly, the duration of colonization could only be experienced in colonized countries, and this was on average more pronounced in the densely populated countries colonized by Spain (Ashraf and Galor, 2013).

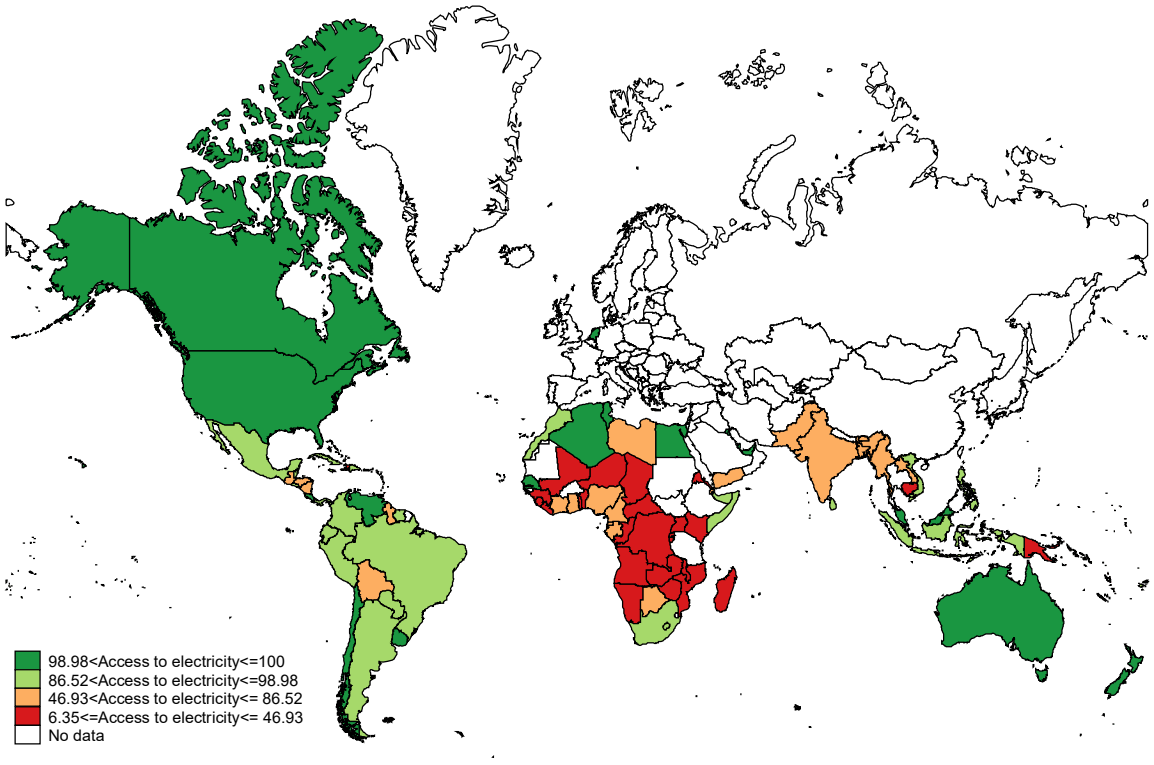
3.2 Data

In this study, we use a global sample of 126 countries[2] with available data on access to electricity and colonial duration for the period spanning from 2000 to 2021. The time period and the corresponding number of countries are contingent on data availability constraints at the time of study. The data comes mainly from three sources: Nunn and Puga (2012), Olsson (2009), and the World Bank (2023).

Access to electricity

We use the World Bank's index of total access to electricity. It refers to the proportion of the country's total population with electrical access. This index can be divided into two main components: rural and urban. Figure 1 show how access to electricity is distributed across the 126 countries of our sample. This figure reveals that, in general, most African countries have difficulty accessing electricity compared to countries on other continents.

Figure 1: Distribution of access to electricity for 126 countries

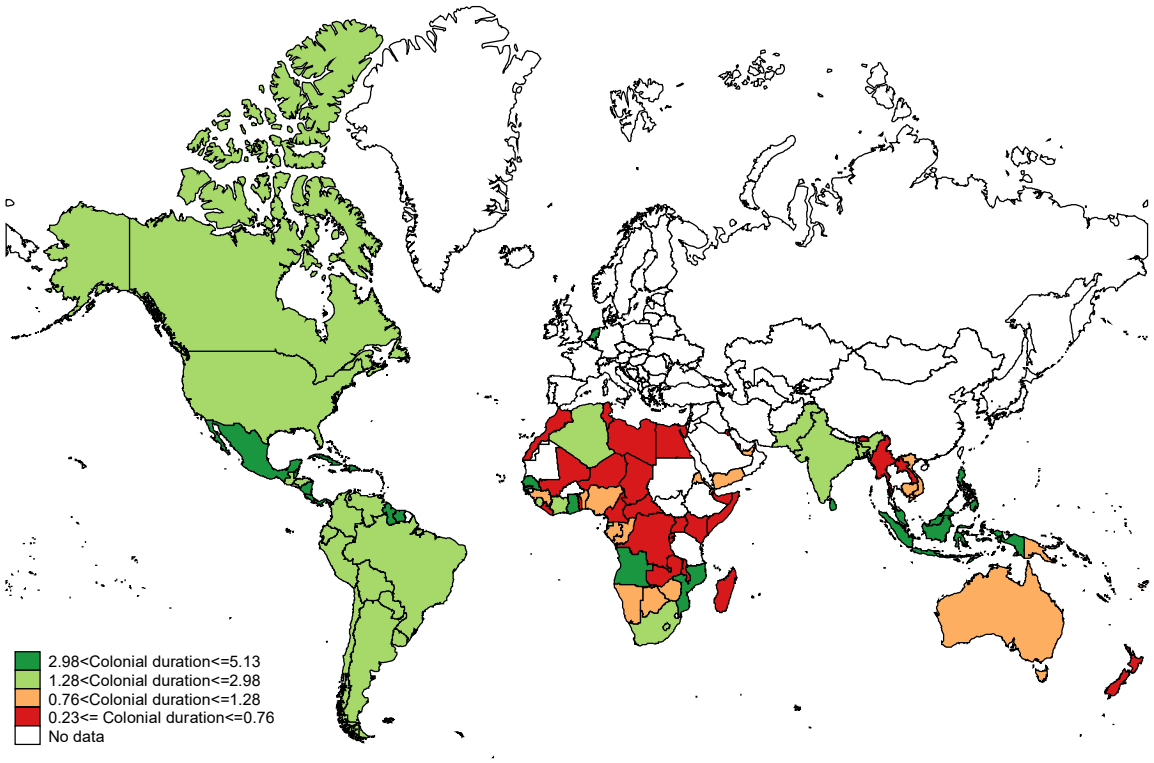


[2] See Appendix A2 for more details.

Colonial duration

According to Ashraf and Galor (2013), colonial duration refers to the duration, in centuries, of experience by a country as a colony of one or more colonial powers. These include the United Kingdom, France, Spain, Portugal, the Netherlands, Belgium, Italy, Germany, and the United States. This variable was constructed by dividing the difference between the year of independence and the year of colonization by 100 (Olsson, 2009). An examination of the data on this variable shows that they range on average from 0 to 6. The duration increases as the values move away from zero. Figure 2 shows the distribution of the duration of colonization in our sample of 126 countries. A close look at this figure shows that, on average, African countries experienced the shortest periods of colonization.

Figure 2: Distribution of colonial duration for 126 countries



4. Empirical Results

4. 1 Main Results

4.1.1 Ordinary Least Squares results

The results of estimating equation (1) using the Ordinary Least Squares (OLS) method are presented in Table (1) below. Model (1) includes no controls, Model (2) adds terrain ruggedness, the percentage of tropical climate and desert, Model (3) in addition controls for continental dummy variables, including Africa, Asia, and South America. The effect of institutional quality, measured by government effectiveness, political stability and regulatory quality, is control for Model (4). Finally, we add economic and population growth in Model (5). This completes the set of baseline

controls. The influence of colonial duration on access to electricity is positive and significant for all five Models. In other words, the countries whose populations have more access to electricity today are those that have been colonized for longer periods of time. This supports the view that the colonies, which have experienced longer periods of colonization, have inherited important infrastructure and institutional legacies, which undoubtedly gives them advantages today in terms of distribution and access to electrical energy.

Two control variables have negative and significant coefficients: the percentage of tropical climate and the Africa dummy variable. The negative effect of tropical climate suggests that people living in tropical areas have difficulties in accessing electricity. A possible explanation for this result is that exposure to tropical climate reduces economic growth (Bloom and Sachs, 1998) and therefore access to electricity (Nguyen and Su, 2022). The negative effect of the Africa dummy variable for its part indicates that access to electricity remains a serious problem in Africa. This finding is consistent with World Bank (2022) statistics, which show that almost 47% of the African population lives without electricity.

Table 1: **Effect of colonial duration on access to electricity: OLS estimates**

Variables	**Model(1)**	**Model (2) Add geographical variables**	**Model (3) Add continental dummies**	**Model (4) Add institutional quality**	**Model (5) Add economic and population growth**
Colonial duration	0.164***	0.181***	0.100***	0.0811**	0.0700**
	(0.0437)	(0.0466)	(0.0368)	(0.0362)	(0.0341)
Terrain ruggedness		-0.0543	-0.0623*	-0.0641**	-0.0867**
		(0.0467)	(0.0326)	(0.0323)	(0.0353)
% Tropical climate		-0.00258**	-0.00346***	-0.00247**	-0.00256**
		(0.00117)	(0.00105)	(0.00105)	(0.00109)
% Desert		-0.00291	-0.00114	-0.000273	0.00158
		(0.00767)	(0.00547)	(0.00512)	(0.00479)
Africa			-0.776***	-0.567***	-0.461***
			(0.125)	(0.129)	(0.144)
Asia			0.00132	0.101	0.196
			(0.0881)	(0.100)	(0.138)
South America			-0.0120	0.169*	0.155
			(0.0562)	(0.0922)	(0.105)
Government effectiveness				0.257**	0.192
				(0.125)	(0.120)
Political stability				0.162**	0.156**
				(0.0639)	(0.0644)
Regulatory quality				-0.231**	-0.179*
				(0.103)	(0.101)
Economic growth					0.00943
					(0.0276)
Population growth					-0.105**
					(0.0464)
Constant	3.829***	4.029***	4.542***	4.415***	4.568***
	(0.119)	(0.147)	(0.141)	(0.153)	(0.159)
Observations	126	126	126	123	123
R-squared	0.126	0.154	0.457	0.523	0.547

Notes: Robust standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5% and 1% levels, respectively.

4.1.2 IV-2SLS Results

The results of IV-2SLS are presented in Table (2). For all specifications, the diagnostic tests shown at the bottom of Table (2) indicate that the over-identification test is insignificant and the under-identification test is significant. The fact that the over-identification test is not significant allows us to confirm the validity of the instruments used. The significance of the under-identification test, on the other hand, tell us that these instruments are not redundant and are therefore all necessary. In this way, our econometric results are not biased and can therefore be interpreted.

Table 2: **Effect of colonial duration on access to electricity: IV-2SLS estimates**

Variables	**Model (6)**	**Model (7)** Add geographical variables	**Model (8)** Add continental dummies	**Model (9)** Add institutional quality	**Model (10)** Add economic and social variables
Colonial duration	0.339***	0.414***	0.265**	0.350***	0.374***
	(0.0637)	(0.0766)	(0.115)	(0.0951)	(0.107)
Terrain ruggedness		-0.0236	-0.0477	-0.0577	-0.0686*
		(0.0537)	(0.0353)	(0.0368)	(0.0406)
% Tropical climate		-0.00466***	-0.00433***	-0.00450***	-0.00478***
		(0.00168)	(0.00138)	(0.00162)	(0.00169)
% Desert		0.00268	0.00143	0.00335	0.00469
		(0.00691)	(0.00555)	(0.00505)	(0.00494)
Africa			-0.568***	-0.404**	-0.317*
			(0.196)	(0.172)	(0.182)
Asia			0.160	0.315*	0.421**
			(0.164)	(0.167)	(0.213)
South America			-0.0141	0.0828	0.0771
			(0.0765)	(0.111)	(0.120)
Government effectiveness				0.122	0.0602
				(0.152)	(0.161)
Political stability				0.154**	0.157**
				(0.0675)	(0.0695)
Regulatory quality				-0.216*	-0.185
				(0.130)	(0.139)
Economic growth					-0.00772
					(0.0334)
Population growth					-0.0661
					(0.0526)
Constant	3.450***	3.609***	4.119***	3.861***	3.906***
	(0.178)	(0.199)	(0.318)	(0.271)	(0.305)
Observations	116	116	116	114	114
Under-identification test	19.30*** $[P-val=0.00]$	18.41*** $[P-val=0.00]$	7.34** $[P-val=0.02]$	12.45*** $[P-val=0.00]$	12.20*** $[P-val=0.00]$
Over-identification test of all instruments	2.01 $[P-val=0.15]$	2.66 $[P-val=0.10]$	0.41 $[P-val=0.51]$	0.98 $[P-val=0.32]$	0.68 $[P-val=0.40]$

Notes: Robust standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5% and 1% levels, respectively. Population density in 1400 and Spanish colonial origin dummy are used as excluded instruments. The null hypothesis of the under-identification test states that the instruments are redundant. The null hypothesis of the over-identification test is that the instruments are valid.

Regarding the estimated coefficients, consistent with the OLS results, it appears that colonial duration has a positive and statistically significant effect on the percentage of total population with access to electricity in all specifications. The estimated coefficient of 0.374 in Model (10) as a simple economic interpretation that one hundred more years of colonization increases access to electricity by 0.374 units. This lends credibility to our theoretical argument that countries that have been colonized for longer periods are better equipped in terms of electricity distribution infrastructure. Our finding is therefore in line with the strand of literature which shows that longer colonization periods are associated with better economic outcomes (Grier, 1999; Olsson, 2009; Njoh and Akiwumi, 2011). As first seen in Table (1), the results in Table (2) also show that the percentage of tropical climate and the Africa dummy variable have a negative effect on access to electricity. Specifically, in Model (10), the estimated coefficient of the percentage of the tropical climate is -0.00478, meaning that a one-unit increase in the tropical climate share contributes to a 0.478% decrease in access to electricity. Concerning the estimated coefficient on the Africa dummy variable (-0.317 in Model 10), its economic significance means that African countries have less than 31% access to electricity. This therefore tends to reinforce the fact that access to electricity is low in tropical areas and in Africa.

4.2 Robustness checks

To verify the sensitivity of our results reported in Table 2, we test the robustness. We do this first by introducing other control variables and then by disaggregating the total population with access to electricity into rural and urban areas. Estimates are also made using IV-2SLS method.

4.2.1 Are the results robust when other effects are taken into account?

Here we return to the results reported in the last column of Table (2) and perform robustness checks by controlling for other contemporaneous drivers of access to electricity. The results report in Table (3), Model (11), indicate that the inclusion of credit to private sector and oil rents does not change the influence of colonial duration on access to electricity. It is also important to note here that the effect of the percentage of tropical climate also remains unchanged.

4.2.2 Are the results robust to a breakdown of electricity access into urban and rural areas?

We then repeat the IV-2SLS estimates in the last column of Table (2) for disaggregated access to electricity in urban and rural areas. The results are reported in the last two columns of Table (3), for urban and rural areas respectively. The signs and economic significance of the coefficients on colonial duration and tropical climate percentage are similar to those obtained in Table (2). Therefore, our results remain robust when we disaggregate access to electricity into urban and rural areas.

Table 3: Robustness Checks

Variables	Model (11) Add additional control variables	Break total access to electricity into two parts Model (12) Access to electricity in urban area	Model (13) Access to electricity in rural area
Colonial duration	0.434***	0.143***	0.484***
	(0.134)	(0.0439)	(0.148)
Terrain ruggedness	-0.0448	-0.0143	-0.0668
	(0.0456)	(0.0190)	(0.0645)
% Tropical climate	-0.00393**	-0.00207***	-0.00753***
	(0.00192)	(0.000759)	(0.00273)
% Desert	0.00407	0.00246	0.00926
	(0.00472)	(0.00219)	(0.00679)
Africa	-0.237	-0.206***	-0.670**
	(0.216)	(0.0751)	(0.274)
Asia	0.383	0.140**	0.623**
	(0.265)	(0.0687)	(0.249)
South America	7.53e-05	0.00958	0.144
	(0.120)	(0.0523)	(0.189)
Government effectiveness	0.00190	0.0353	0.270
	(0.188)	(0.0649)	(0.250)
Regulatory quality	-0.207	-0.0976	-0.332
	(0.177)	(0.0603)	(0.212)
Political stability	0.0980	0.0629**	0.212*
	(0.0781)	(0.0308)	(0.125)
Population growth	-0.103*	-0.0163	-0.165**
	(0.0610)	(0.0220)	(0.0799)
Domestic credit to private sector	0.00495*		
	(0.00254)		
Economic growth	-0.00886		
	(0.0406)		
Oil rents	0.0141*		
	(0.00808)		
Constant	3.472***	4.350***	3.726***
	(0.477)	(0.130)	(0.428)
Observations	107	113	113
Underidentification test	8.21**	13.67***	13.67***
	$[P-val=0.016]$	$[P-val=0.00]$	$[P-val=0.00]$
Overidentification test	1.77	0.70	0.35
	$[P-val=0.18]$	$[P-val=0.40]$	$[P-val=0.55]$

Notes: Robust standard errors are in parentheses. ***, ** and * indicate significance at the 1%, 5% and 1% levels, respectively. Population density in 1400 and Spanish colonial origin dummy are used as excluded instruments. The null hypothesis of the under-identification test states that the instruments are redundant. The null hypothesis of the over-identification test is that the instruments are valid.

4.3 Mediation Analysis

Previous results suggested that countries that have been under colonial rule for a long period enjoy better access to electricity today. Now we test for transmission channels using the mediating variables of political stability, secondary school enrollment, and population growth.

According to Baron and Kenny (1986), testing a transmission channel involves estimating three regression equations. The first (Equation 2), analyses the effect of colonial duration (Duration) on access to electricity (Access). The second regression (Equation 3) estimates the effect of colonial duration on the mediator "M", which may be political stability, secondary school enrollment, or population growth. Finally, the last equation (Equation 4) estimates the influence of the mediator concerned on access to electricity in the presence of colonial duration. At the end of the process, mediation may be partial or full. Partial mediation occurs when the effect of colonial duration is less in Equation (2) than in Equation (4). On the other hand, mediation is said to be full when colonial duration has an insignificant effect on access to electricity in the presence of the mediator (Equation 4). However, it is important to add that the intensity of the indirect effect is given by the product of b_2 and c_3, where c_3 measures the strength of the correlation between access to electricity and the mediator concerned in Equation (4). This term also reflects the size of the mediation, which depends upon the extent to which Duration influences the mediator (b_2) and the degree to which the mediator affects Access (c_3).

Equation (2): $Access_i = a_1 + b_1 Duration_i + c_1 Controls_i + \varepsilon_i$

Equation (3): $M_i = a_2 + b_2 Duration_i + c_2 Controls_i + v_i$

Equation (4) $Access_i = a_3 + b_3 Duration_i + c_3 M_i + c_4 Controls_i + u_i$

Indirect effect $= b_2 * c_3$; Direct effect = b_3; Total effect = $(b_2 * c_3) + b_3$

Table (4) presents the results of the investigations of how the influence of colonial duration on access to electricity operates through its effect on political stability, school enrollment, and population growth. This is done based on the Sobel test statistical approach popularized by Mackinnon et al. (1995). The Delta test is an alternative mediation test. Models (15) and (16) in Table (4) display the results of equations (3) and (4) respectively for the political stability channel. While the results of Model (15) show that colonial duration has a positive and significant influence on political stability, the results of Model (16) show that political stability has a positive and statistically significant effect on access to electricity. We can therefore conclude that colonial duration enhances access to electricity by improving political stability**.** This undoubtedly validates the mediating role of political stability. The significance of the Sobel and Delta statistics at the bottom of Models (15) and (16) also confirms this. Indeed, the results show that political stability accounts for 27% of the effect of the length of colonization on access to electricity.

Regarding the mediating role of school enrolment, Models (17) and (18) in Table (4) summarise the results. The statistics from the Sobel and Delta tests are all significant at the 1% level. This highlights the effective mediating role of education. Indeed, Model (17) shows that the coefficient on colonial duration is positive and statistically significant, revealing that colonial duration is associated with a higher level of education. Furthermore, Model (18) shows that the school enrolment has a positive and statistically significant effect on access to electricity. Therefore,

countries that have been under colonial rule for a long period benefit all the more from greater access to electricity, partly because of the promotional effect of colonial duration on education. We find that school enrolment explains 46% of the effect of colonial duration on access to electricity.

Finally, regarding the mediating role of population growth, Models (19) and (20) in Table (4) show respectively that colonial duration has a negative and statistically significant effect on the population growth and that the latter in turn, has a negative and statistically significant effect on access to electricity. Therefore, countries that have been under colonial rule for longer periods benefit more from greater access to electricity, partly because of the adverse effect of colonial duration on population growth. We find that 38% of the effect of colonial duration on access to electricity is mediated by population growth. This is confirmed by the significance at the 5% level of the Sobel and Delta test statistics.

Table 4: **Results of the mediation analysis**

Dependent variables	**Political stability channel**		**Education channel**		**Population growth channel**	
	Political stability	Access	Secondary school enrolment	Access	Population growth	Access
Independent variables	**Model (15)**	**Model (16)**	**Model (17)**	**Model (18)**	**Model (19)**	**Model(20)**
Colonial duration	0.163*** (0.0596)	0.0700** (0.0347)	7.677*** (2.185)	0.103** (0.0480)	-0.373*** (0.0761)	0.101** (0.0461)
Political stability		0.156*** (0.0585)				
Secondary school enrolment				0.0116*** (0.00353)		
Population growth						-0.163*** (0.0578)
Basic control variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.415*** (0.144)	4.568*** (0.164)	43.13*** (5.430)	3.765*** (0.405)	2.649*** (0.174)	4.748*** (0.224)
Observations	123	123	67	67	99	99
Indirect effect Sobel test	0.057* $P-val=0.052$		0.206*** P-val=0.007		0.117** $P-val=0.01$	
Indirect effect Delta test	0.057* $P-val=0.053$		0.206*** P-val=0.007		0.117** $P-val=0.01$	
% of total effect mediated	27%		46%		38%	
Decision	**Partial mediation**		**Partial mediation**		**Partial mediation**	

Notes: Standard errors are in parentheses *** p<0.01, ** p<0.05, * p<0.1. The Basic control variables correspond to all the control variables listed in Model (3) of Table (1).

5. Conclusion

Lack of access to electricity is a major challenge for social and economic development of countries. To address this challenge, it is important to identify the drivers of access to electricity. In this paper, we attempt to shed new light on that issue by establishing a link between colonial duration and access to electricity. Using a cross-sectional dataset from a sample of 126 countries, we find that the populations with greatest access to electricity today live in countries that have experienced longer periods of colonization. This finding is robust to the inclusion of other potential effects (credit to private sector and oil rents) and to the disaggregation of access to electricity into rural and urban areas. In addition, our study also highlights the mediating roles of political stability, education, and population growth. Indeed, the results of the mediation tests showed that the positive influence of the length of colonization on access to electricity is partly explained by greater political stability, higher levels of education, and lower rates of population growth. Specifically, political stability, education, and population growth were found to account respectively for 27%, 46%, and 38% of the effect of colonial duration on access to electricity.

Based on these findings, we have suggested that countries with a short history of colonization should implement policies that not only promote political stability and education but also slow down population growth to ensure that their populations have greater access to electricity. For example, to make their political systems more stable, these countries can promote tolerance, understanding, and cooperation among different social and ethnic groups. To promote education, these countries can increase the number of schools, teachers, and resources to ensure access to education for all. To slow population growth, these countries can promote gender equality and empower women to make informed decisions about their reproductive health and family planning. This study is certainly interesting, but it seems to overlook the possibility of a non-linear relationship between colonial duration and access to electricity. Future studies can therefore improve the existing literature by taking these aspects into account.

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Appendices

Appendix A: Definition of variables and data source

Variable	Description	Source
Access to electricity	It refers to the percentage of total population with access to electricity.	World Bank (2023)
Colonial duration	It reflects the extent of the period during which a country has been under colonial rule	Olsson(2009)
Terrain ruggedness	An index that quantifies small-scale terrain irregularities in each country	Nunn and Puga (2012)
%Tropical climate	It refers to the percentage of the land surface area of each country that has the four Koppen-Geiger tropical climates	Nunn and Puga(2012)
% Desert	The percentage of land surface area of each country covered by sandy desert, dunes, rocky or lava flows	Nunn and Puga(2012)
Africa	A dummy variable representing African countries	Nunn and Puga(2012)
South-America	A dummy variable representing South-American countries	Nunn and Puga(2012)
Asia	A dummy variable representing Asian countries	Nunn and Puga(2012)
Government effectiveness	It captures the perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	World Bank (2023)
Political stability	An Index that reflects the perceived likelihood that the government will be destabilised by unconstitutional means, including politically motivated violence and terrorism	World Bank (2023)
Regulatory quality	An index that captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	World Bank (2023)
Population density in 1400	The population in 1400 divided by land area	Nunn and Puga(2012)
Spanish colonial origin dummy	A binary variable representing the countries colonised by Spain.	Nunn and Puga(2012)
Oil rents	They reflect the difference between the value of crude oil production at regional prices and total costs of production.	World Bank (2023)
School enrolment	It refers to the percentage of the secondary school-age population enrolled in secondary school	World Bank(2022)
Credit to private sector	It refers to the financial resources provided to the private sector by financial corporations.	World Bank (2023)
Economic growth	It refers to the Annual percentage growth rate of GDP per capita based on constant local currency.	World Bank(2023)
Population growth	It is the annual growth rate of a country’s total population.	World Bank(2023)

Appendix B: List of countries included in the estimations

Country name	Code	Country name	Code	Country name	Code	Country name	Code
Algeria	DZA	Ecuador	ECU	Micronesia. Fed. Sts.	FSM	Togo	TGO
American Samoa	ASM	Egypt. Arab Rep.	EGY	Morocco	MAR	Tonga	TON
Angola	AGO	El Salvador	SLV	Mozambique	MOZ	Trinidad and Tobago	TTO
Argentina	ARG	Equatorial Guinea	GNQ	Myanmar	MMR	Tunisia	TUN
Aruba	ABW	Eritrea	ERI	Namibia	NAM	Turks and Caicos Islands	TCA
Australia	AUS	Fiji	FJI	Nauru	NRU	Tuvalu	TUV
Bahamas	BHS	Gabon	GAB	Netherlands	NLD	Uganda	UGA
Bahrain	BHR	Gambia. The	GMB	New Caledonia	NCL	United Arab Emirates	ARE
Bangladesh	BGD	Ghana	GHA	New Zealand	NZL	United States	USA
Barbados	BRB	Grenada	GRD	Nicaragua	NIC	Uruguay	URY
Belize	BLZ	Guam	GUM	Niger	NER	Vanuatu	VUT
Benin	BEN	Guatemala	GTM	Nigeria	NGA	Venezuela. RB	VEN
Bermuda	BMU	Guinea	GIN	Pakistan	PAK	Vietnam	VNM
Bhutan	BTN	Guyana	GUY	Palau	PLW	Yemen. Rep.	YEM
Bolivia	BOL	Haiti	HTI	Panama	PAN	Zambia	ZMB
Botswana	BWA	Honduras	HND	Papua New Guinea	PNG	Zimbabwe	ZWE
Brazil	BRA	Hong Kong SAR. China	HKG	Paraguay	PRY		
British Virgin Islands	VGB	India	IND	Peru	PER		
Brunei Darussalam	BRN	Indonesia	IDN	Philippines	PHL		
Burundi	BDI	Ivory Coast	CIV	Puerto Rico	PRI		
Cambodia	KHM	Jamaica	JAM	Qatar	QAT		
Cameroon	CMR	Kenya	KEN	Rwanda	RWA		
Canada	CAN	Kiribati	KIR	Saint Kitts and Nevis	KNA		
Cape verde	CPV	Kuwait	KWT	Saint Lucia	LCA		
Cayman Islands	CYM	Lao PDR	LAO	Saint Vincent and the Grenadines	VCT		
Central African Republic	CAF	Lesotho	LSO	Samoa	WSM		
Chad	TCD	Liberia	LBR	Sao Tome and Principe	STP		
Chile	CHL	Libya	LBY	Senegal	SEN		
Colombia	COL	Macao SAR. China	MAC	Seychelles	SYC		
Comoros	COM	Madagascar	MDG	Sierra Leone	SLE		
Congo. Dem. Rep.	COD	Malawi	MWI	Singapore	SGP		
Congo. Rep.	COG	Malaysia	MYS	Solomon Islands	SLB		
Costa Rica	CRI	Maldives	MDV	Somalia	SOM		
Cuba	CUB	Mali	MLI	South Africa	ZAF		
Djibouti	DJI	Marshall Islands	MHL	Sri Lanka	LKA		
Dominica	DMA	Mauritius	MUS	Sudan	SDN		
Dominican Republic	DOM	Mexico	MEX	Suriname	SUR		