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THE ROLE OF GOVERNANCE IN REMITTANCES-ACCESS TO ELECTRICITY NEXUS IN SUB-SAHARAN AFRICA? A RURAL-URBAN COMPARATIVE ANALYSIS

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Abstract

Purpose: This study examines the influences of remittances and governance in enhancing access to electricity in 40 sub-Saharan African (SSA) countries.

Methodology: Using 5 years of non-overlapping from 1990 to 2022 using the System-Generalised Method of Moment (System-GMM), with a particular focus on the rural-urban divide.

Findings: Evidence from the unconditional regression indicates that an additional migrant remittance received results in 8.7 and 23.4 increase in rural and urban access to electricity respectively. Second, the interactive regressions also indicate that corruption control, voice and accountability and government effectiveness exhibit negative synergies with remittances to influence rural access to electricity. In urban SSA, corruption control has positive synergies with remittances to enhance access to electricity. Voice and accountability interact with remittance, yielding a 1.76 governance threshold for complementary policies.

Originality/Value: The current empirical research bridges the research gap in the context of exploring the role that governance plays in influencing the effect of remittances on rural and urban access to electricity based on both conditional and unconditional analysis.

Keywords: remittances, access to electricity, urban, rural, sub-Saharan Africa

JEL *Classifications*: D31, O15, F24

1. Introduction

Many sub-Saharan African (SSA) countries have already committed to putting strategies in force to minimise greenhouse gas emissions by switching to clean energy production in the wake of the Paris Climate Agreement. Electricity is recognised as one of such clean energies however its access varies significantly across SSA, with rural areas having significantly lower rates than urban areas (17 percent versus 59 percent, respectively) (Trotter, 2016). In rural SSA, rural folks are 3.5% behind in energy access compared to metropolitan areas thus reinforcing that rural SSA needs to accelerate its expansion (Zigah and Creti, 2023). Migrant remittance, though at its infancy level in the SSA region, has emerged as a weighty source of funding for enhancing socio-economic outcomes despite the argument that they may be detrimental to socio-economic expansion (Cazachevici, Havranek and Horvath 2020; Karpestam, 2012). SSA's migrant remittances as a proportion of GDP varied from 2000 to 2021, peaking at 2.7% in 2018 after first averaging 1.2% in the early 2000s, then declining somewhat and then slightly increasing to 2.57% in 2021 (Choumert-Nkolo and le Roux, 2024).

This study is motivated by the pressing policy issue of electricity inequality in SSA, where rural communities are disproportionately affected by energy poverty and access to electricity is still unequal across rural and urban areas (Simcock and Petrova, 2017; Day, Walker, and Simcock, 2016). Inclusive energy policies that give rural development first priority are necessary to achieve the Sustainable Development Goals (SDGs), especially "leaving no one behind" idea (Chakrabarti and Amarnath, 2023). Remittances from migrants have become a potentially revolutionary source of household income by increasing the purchasing power of beneficiaries in this region, with the potential to lessen inequalities in access to electricity (Beecher, 2021; Nepal, Park and Lee, 2020). This will provide households with an opportunity to invest in equipment and varied energy services (Djeunankan et al., 2023; González Bautista et al., 2024). However, the larger institutional architecture can influence how remittances affect access to electricity. Transforming income gains into better energy outcomes through wise infrastructure investments and fair service delivery requires effective governance (Ahlborg et al., 2015; Cowen, 2024). On the other hand, access to energy is sometimes compromised by weak institutions (Trotter, 2016; Kosec and Wantchekon, 2020). Therefore, resolving the rural-urban disparity in electricity access requires a knowledge of how remittances and governance interact.

There is still a dearth of empirical investigation despite the obvious hypothetical connections between migrant remittances, governance and access to electricity. Literature on remittances and electricity access falls into two main strands with diverging results. The first strand of studies (Murshed, 2023; Onuonga, 2020) indicates no direct effect of remittances on energy (electricity). In contrast, the second strand provides substantial evidence of a positive relationship between remittances and electricity access. Adu–Darko (2019) found that remittances significantly boosted household expenditure on electricity in Ghana. Other studies (Barry and Creti, 2020; Agradi, 2023; Nzabamwita, 2021; Barkat, Alsamara and Mimouni, 2023) emphasized how remittances ease energy poverty by funding household energy investments, especially in off-grid and rural areas. Acheampong, Brahim and Dzator (2024) and Shahbaz et al. (2024) highlighted the role of governance and financial infrastructure in amplifying the impact of remittances.

Despite these contributions, critical gaps remain. Much of the literature neglects a sub-regional perspective, particularly the role of governance in mediating the remittance-electricity nexus. The study of Gamette, Odhiambo and Asongu (2024), which examines the role of governance in the connection between remittances and energy access is most closely related to this one. In contrast to Gamette, Odhiambo and Asongu (2024), this present study adopts a geographical perspective approach regarding the interactive effect of remittance and governance on access to electricity as well as considers how domestic conditions—such as ICT penetration and private sector access to credit—shape outcomes. This study uses panel data from 1990 to 2022 on SSA countries to investigate the following specific research questions in order

to guide initiatives and policies aimed at achieving SDG7 and resetting economic expansion in both rural and urban areas in SSA countries.

i. To what extent does governance amplify or dilute the influence of migrant remittances on rural and urban access to electricity in SSA countries?
ii. What is the governance thresholds at which migrant remittances impact rural and urban access to electricity?

The rest of the study is arranged as follows. Section 2 discusses the data and methodology used in this study. Section 3 is devoted to the empirical results and discussions. Section 4 presents the conclusion and policy implications.

2. Data and Methodology

2.1 Data

Data from 40 SSA countries covering 1990 – 2022 are used in the study. The number of countries and related periodicity are limited because of difficulties obtaining electrical statistics throughout the study period. The data are arranged into non-overlapping intervals to match the data format with the pragmatic approach used in this study. This ensures that there are more cross-sections than annual observations in each cross-section, which is a requirement for using the GMM methodology (Asongu, Nnanna and Acha-Anyi, 2020). Due to the limitations of the data at hand, the study produces seven non-overlapping averages over a period of five years for six non-overlapping and one non-overlapping average across three years. Nevertheless, a preliminary examination shows that the three-year and five-year averages cause instrument proliferation, leading to inaccurate model predictions, even when the possibility of collapsing instruments is taken into thought. Consequently, the analysis adopts 1990 -1994; 1995 -1999; 2000 -2004; 2005 – 2009; 2010 -2014; 2015 – 2019 and 2020 – 2022.

The primary explanatory variable is migrant remittances as a percentage of GDP, which is derived from the World Bank Development Indicators database together with information on electricity access. The Gross Domestic Product (GDP), Food Production Index (FPI), Gross Domestic Savings (GDS), Domestic Credit to the Private Sector (DCPS), and information and communication technology (ICT) indicators—such as internet users, mobile cellular subscriptions, and broadband subscriptions per 100 people—are also available from the same source. The literature now in publication acknowledges these factors as important factors that influence access to electricity (Murshed, 2023; Barkat, Alsamara and Mimouni, 2023; Hosan et al., 2023; Agradi, 2023; Djeunankan et al., 2023). GDP growth enables governments to improve access to electricity by expanding energy infrastructure (Murshed, 2023). A gauge of agricultural production, the FPI boosts economic growth, especially in rural regions, and increases the demand for energy for household and agricultural processing (He et al., 2024, Subramaniam, Masron and Azman, 2022). By permitting private sector investment in infrastructure like power plants and decentralised grids, DCPS makes energy accessibility easier (Barkat, Alsamara, and Mimouni, 2023). While GDS provides crucial funding for both public and private investments in the energy sector, ICT developments help bring off-grid and decentralised renewable energy solutions to rural locations (Murshed, 2023; Asongu, Biekpe and Tchamyou, 2019). Electricity accessibility is also anticipated to be influenced by governance variables drawn from the World Bank Governance variables database, including political stability, voice and accountability, government effectiveness, regulatory quality, rule of law and control of corruption. Access is improved by advancements in these areas although it is anticipated that increased levels of corruption will impede it (Djeunankan et al., 2023; Murshed, 2023). Appendix I contains information on the variables' definitions and sources, Appendix II presents the trends of Remittances in SSA (1990-2023), Appendix III provides an overview of the summary statistics, Appendix IV displays the correlation matrix and Appendix V and VI display the net effects and governance threshold points.

2.2 Specification

The data section has previously shed light on the decision to use the GMM empirical method, particularly on the necessity of restructuring the data to meet a basic prerequisite for using the estimate methodology. The N>T criterion, which is necessary for selecting the empirical procedure, is thus satisfied after reorganising the dataset into 7 5-year discrete intervals. The following are further explanations for the technique's selection: There is (i) persistence in the dynamics of electricity access since their level series and first difference have been linked to a height greater than 0.800—the cutoff point known as the "rule of thumb" in modern GMM-oriented research that establishes persistence in an outcome indicator (Asongu, Le Roux and Biekpe, 2017; Tchamyou, Erreygers and Cassimon, 2019). (ii) The estimating exercise takes into consideration

cross-country heterogeneity due to the panel-oriented nature of the data format. In order to resolve simultaneity or reverse causality, internal instruments are employed and time-invariant missing pointers are also used to justify the unobserved variability. These two basic principles handle the endogeneity problem, which is essential for a sound empirical investigation. Levels (1) and first difference (2) provide an outline of how governance dynamics change migrant remittances to impact power access.

For this study, other estimators such two-stage least squares (2SLS) and fixed effects (FE) were considered inappropriate. FE models are unsuitable for dynamic panels with the lagged dependent variable included as a regressor because they do not take into consideration the endogeneity of explanatory variables. Similar to this, 2SLS depends on powerful external tools that are frequently challenging to locate and verify in macro-panel data. By utilising internal tools and taking use of the dynamic nature of panel data, the system-GMM estimator effectively handles endogeneity, autocorrelation and omitted variable bias (Arellano & Bover, 1995; Blundell & Bond, 1998; Roodman, 2009). Equation (1) represents a dynamic panel model estimating access to electricity (ACE) as a function of its lag, remittances (RMIT), governance (GOV), and their interaction, along with control variables (W), country-specific effects (n_{zi}), and time effects (ϵ_t). This formulation captures both persistence and the potential moderating effect of governance on remittances. Equation (2) is its first-differenced form, which eliminates unobserved heterogeneity and addresses endogeneity by using past values as instruments.

$$ACE_{zi,t} = \beta_0 + \beta_1 ACE_{zi,t-\tau} + \beta_2 RMIT_{zi,t} + \beta_3 GOV_{zi,t} + \beta_4 (RMIT_{zi,t} * GOV_{zi,t}) + \sum_{h=1}^{5} \delta_h W_{h,zi,t-\tau} + n_{zi} + \epsilon_t + \varepsilon_{zi,t,} \quad (1)$$

$$ACE_{zi,t} - ACES_{zi,t-\tau} = \beta_1 (ACE_{zi,t-\tau} - ACE_{zi,t-2\tau}) + \beta_2 (RMIT_{zi,t} - RMIT_{zi,t-\tau}) + \beta_3 (GOV_{zi,t,} - GOV_{zi,t-\tau}) + \beta_4 (RMIT_{zi,t} * GOV_{zi,t,} - RMIT_{zi,t} * GOV_{zi,t-\tau}) + \sum_{h=1}^{5} (W_{h,z\,i,t-\tau} - W_{h,zi,t-2\tau}) + (\epsilon_t - \epsilon_{t-\tau}) + (\varepsilon_{zi,t} - \varepsilon_{zi,t-\tau}) \quad (2)$$

where $ACE_{zi,t}$ denotes percentage of rural or urban population with access to electricity of country i in period t; $RMIT_{zi,t}$ represents migrant remittances in rural and urban areas; GOV is governance indicators (governance index, government effectiveness, regulatory quality, voice and accountability, rule of law, political stability and level of corruption); $RMIT_{zi,t} * GOV_{zi,t,}$ denotes the interaction between migrant remittances and governance in rural and urban areas; β_0 is a constant; τ is the level of auto-regression, which is recognised as one in this study since prior data must be captured using a one-period lag or a five-year non-overlapping interval; The vector of control variables is included in this (Gross domestic product, Food Production Index, Domestic Credit to Private Sector, Information Communication Technology and Gross domestic savings), n_i is the country-specific effect for either rural or urban areas, ϵ_t is the time-specific constant and $\varepsilon_{zi,t,}$ is the error term. The equation caters for only the relative effect of migrant remittances on rural and urban access to electricity.

Through thorough diagnostic testing, the study guarantees the reliability of the system GMM estimations and the validity of the instruments. In particular, as suggested by Hansen (1982), the Hansen test for over-identifying limitations was used to determine whether the instruments are exogenous. The validity of the instruments utilised is confirmed when the null hypothesis cannot be rejected. Furthermore, the exogeneity of the instrument subsets was tested using the Difference-in-Hansen Test (DHT), which requires the null hypothesis to be maintained in order to support exclusion constraints (Asongu et al., 2017). In addition, autocorrelation in the differenced residuals was found using the Arellano-Bond second-order serial correlation test (AR(2)), which was described by Arellano and Bond (1991). The specification of the model and the consistency of the estimators are supported by not rejecting the null hypothesis that there is no second-order autocorrelation. Identification is strengthened when strictly exogenous factors, like the time variable "years" in this study, are handled correctly, as Roodman (2009) highlights. The study complies with the best standards in instrument validity by treating all explanatory variables as

endogenous and controlling and only employing time-invariant variables as strictly exogenous (Asongu and Odhiambo, 2020). When taken as a whole, these diagnostics strengthen the system GMM approach's credibility and resilience.

In Appendix IV, the correlation matrix is presented. Consistent with empirical literature, the correlation matrix is used to examine the correlation among variables used for the study. High correlation values reflect the presence of multicollinearity, and low correlation values denote the absence of multicollinearity. Consistent with this intuition, the correlation between the explanatory variables is not large enough to cause multicollinearity (Brambor, Clark and Golder, 2006).

3. Empirical results

3.1 Presentation of results

The empirical outcome from the System-GMM estimation is shown in Tables 1 and 2 in this section. In Table 1, the first column indicates the independent effect of remittances on rural access to electricity while the subsequent columns (with six specifications) highlight the interactive effect of remittances and governance on rural access to electricity. The overall validity of models for each specification is influenced by two informative criteria. With the following exclusions, the anticipated models are largely valid by these standards: The null hypothesis is rejected. In difference testing, (i) Hansen and (ii) second-order Arellano and Bond autocorrelation. Consequently, net impacts are not computed for these inaccurate models. Tables 1 and 2 show that, at 1% and 5% significance levels, respectively, access to electricity in urban and rural regions increases by 0.0872 and 0.234 for every unit increase in migrant remittances. Therefore, a 1 unit rise in the proportion of remittances to GDP results in 87.2 units upsurge in the number of people in SSA's urban centres who have access to electricity, while the rural population's access to electricity increases by 23.4 units. This aligns with the outcome of Karpestam (2012) that remittances has a multiplier effect in developing economies especially enhancing access to energy. GDP also has a negative effect on access to electricity in rural areas. This is counterintuitive and could be explained from perspective that GDP growth in most SSA countries is often driven by urban-based sectors such as services or telecommunication which do not directly benefit rural areas. Hence, investment in energy infrastructure is usually concentrated in urban areas at the detriment of rural areas. It is also expected that FPI increase rural electrification via incomes from sales of agricultural goods however it was identified that in Table 1, the unconditional FPI reduces access to electricity in rural areas in the presence of corruption, political stability, voice and accountability, regulatory quality and government effectiveness. This could be explained from the point that rural energy infrastructure may not be prioritized in national planning as government fails to integrate agricultural gains into broader rural development strategies. Recent research on joint regressions (Tchamyou and Asongu 2017; Agoba et al., 2020) provided guidance for testing the earlier hypotheses in the case of net effect analysis by calculating the unconditional association between migrant remittances and electricity access as well as the conditional relationship between migrant remittances and electricity access.

Table 1: Remittances, Governance and Rural Access to Electricity

		CORR	POL	RQ	VA	RL	GE
	RPAE	**RPAE**	**RPAE**	**RPAE**	**RPAE**	**RPAE**	**RPAE**
RPAE (-1)	0.739***	0.699***	0.678***	0.687***	**0.608*** **	0.589***	0.600***
	(0.0119)	(0.0169)	(0.0211)	(0.0291)	**(0.0181)**	(0.0174)	(0.0269)
GDP	-1.825***	-3.610***	-4.766***	-4.756***	-4.899***	-4.361***	-5.213***
	(0.271)	(0.652)	(1.034)	(0.854)	(0.892)	(0.606)	(1.017)
FPI	-0.00653	-0.0284**	-0.0511***	-0.0126	-0.0436***	-0.0397**	-0.0600***
	(0.00711)	(0.0134)	(0.0144)	(0.0104)	(0.0131)	(0.0149)	(0.0186)
DCPS	0.302***	0.351***	0.408***	0.242***	0.224***	0.343***	0.180***
	(0.00622)	(0.0147)	(0.0234)	(0.0129)	(0.0140)	(0.0121)	(0.0259)
ICT	0.0325***	0.0156***	-0.000704	0.0344***	0.0342***	0.0258***	0.0325***
	(0.00717)	(0.00510)	(0.00969)	(0.00778)	(0.00611)	(0.00676)	(0.0110)
GDS	0.0818	0.0974	-0.294	-0.0276	0.214***	-0.0138	0.0296
	(0.0677)	(0.0919)	(0.106)	(0.0749)	(0.0638)	(0.0787)	(0.0993)
RMIT	0.234**	-0.276**	-0.878	-1.407***	-0.267	-0.366***	-0.993***
	(0.111)	(0.108)	(0.169)	(0.240)	(0.192)	(0.125)	(0.275)
CORR		9.089***					
		(2.131)					
REMIT*CORR		-1.371***					
		(0.225)					
POL			13.43***				
			(1.299)				
REMIT*POL			-1.491***				
			(0.306)				
RQ				16.59***			
				(0.973)			
RMIT*RQ				16.59***			
				(0.973)			
VA					18.31***		
					(1.650)		
REMIT*VA					-2.233***		
					(0.284)		
RL						15.98***	
						(1.430)	
REMIT*RL						-1.771***	
						(0.235)	
GE							23.93***

REMIT*GE							(1.135) -2.552*** (0.311)
Net Effect	NSA	NS	NA	9.66 (GT)	NA	NS	NS
Constant	10.28*** (2.038)	28.79*** (4.537)	44.28*** (5.877)	44.18*** (5.869)	43.18*** (6.449)	42.56*** (4.446)	56.22*** (5.548)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	240	240	240	240	240	240	240
Number of Country	40	40	40	40	40	40	40
No. of Instruments	37	37	37	37	37	37	37
F- statistics	17968.26	34104.49	25562.88	45541.18	19877.30	54226.50	38020.74
AR (1)	0.038	0.021	0.017	0.013	0.012	0.036	0.008
AR (2)	0.363	0.465	0.463	0.930	0.600	0.564	0.518
Hansen P-value	0.370	0.246	0.594	0.352	0.394	0.302	0.615

Source (s): Authors' own work

*** *p<.01, ** p<.05, * p<.* ***, ** and * Significance levels at 1%, 5% and 10%, respectively. The significance of values is twofold. (1) The significance of estimated coefficients and the Fisher statistics. (2) The failure to reject the null hypotheses of: (a) no autocorrelation in the AR (1) and AR (2) tests. Values in parathesis are standard errors. RPAE is rural population access to electricity, UPAE is urban population access to electricity, RMIT is remittances, GDP is gross domestic product, FPI is food production index, ICT is Information communication technology, GDS is gross domestic savings, DCPS is domestic credit to the private sector, CORR is the level of corruption, POL is political stability, RQ is regulatory quality, VA is Voice and accountability, RL is rule of law and GE is government effectiveness. NA is not applicable, NSA is not specifically applicable, NS is negative synergies, PS is positive synergies, TCP is threshold for complementary policies and GT is governance threshold.

Table 2: Remittances, Governance and Urban Access to Electricity

		CORR	POL	RQ	VA	RL	GE
	UPAE	UPAE	UPAE	UPAE	UPAE	UPAE	UPAE
UPAE (-1)	0.344***	0.363***	0.194***	0.321***	0.341***	0.294***	0.325***
	(0.0491)	(0.0658)	(0.0708)	(0.0663)	(0.0731)	(0.0546)	(0.0507)
GDP	-5.698***	-3.946***	-7.601***	-6.318***	-6.965***	-6.772***	-5.908***
	(1.200)	(1.085)	(1.511)	(1.315)	(1.258)	(1.393)	(1.281)
FPI	0.205***	0.216***	0.129***	0.203***	0.210***	0.147***	0.202***
	(0.0171)	(0.0228)	(0.0278)	(0.0207)	(0.0207)	(0.0288)	(0.0208)
DCPS	0.288***	0.254***	0.543***	0.309***	0.402***	0.387***	0.277***
	(0.0595)	(0.0532)	(0.0726)	(0.0868)	(0.0701)	(0.0736)	(0.0770)
ICT	0.103***	0.115***	0.0574**	0.101***	0.0929***	0.0659***	0.106***
	(0.0225)	(0.0300)	(0.0231)	(0.0243)	(0.0211)	(0.0219)	(0.0240)
GDS	1.079***	1.085***	1.245***	1.066***	1.187***	1.140***	1.105***
	(0.155)	(0.168)	(0.176)	(0.227)	(0.176)	(0.234)	(0.164)
RMIT	0.872***	1.311***	1.781***	0.238	0.816***	0.475	0.878*
	(0.288)	(0.381)	(0.307)	(0.474)	(0.291)	(0.335)	(0.473)
CORR		-7.446***					
		(1.809)					
REMIT*CORR		1.174*					
		(0.628)					
POL			10.85***				
			(2.245)				
REMIT*POL			-3.300***				
			(0.575)				
RQ				4.668**			
				(2.176)			
RMIT*RQ				4.668**			
				(2.176)			
VA					2.628		
					(3.058)		
REMIT*VA					-1.691***		
					(0.568)		
RL						11.76***	
						(2.331)	
REMIT*RL						-2.538***	
						(0.555)	

GE							1.558
							(2.746)
REMIT*GE							-0.0782
							(0.792)
Net Effect	NSA	PS	3.30 (TCP)	NA	1.76 (TCP)	NA	NA
Constant	38.90***	21.06***	56.71***	46.43***	41.89***	54.97***	42.21***
	(6.428)	(7.559)	(9.409)	(7.859)	(9.841)	(8.385)	(7.667)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	240	240	240	240	240	240	240
Number of Country	40	40	40	40	40	40	40
No. of Instruments	37	37	37	37	37	37	37
F- statistics	18827.25	3541.10	18663.50	9638.12	8617.12	12010.61	9948.25
AR (1)	0.001	0.000	0.000	0.000	0.001	0.000	0.001
AR (2)	0.381	0.266	0.450	0.536	0.348	0.389	0.385
Hansen P-value	0.422	0.455	0.601	0.305	0.391	0.501	0.306

Source (s): Authors' own work

*** *p<.01, ** p<.05, * p<.***, ** and * Significance levels at 1%, 5% and 10%, respectively. The significance of values is twofold. (1) The significance of estimated coefficients and the Fisher statistics. (2) The failure to reject the null hypotheses of: (a) no autocorrelation in the AR (1) and AR (2) tests. Values in parathesis are standard errors. RPAE is rural population access to electricity, UPAE is urban population access to electricity, RMIT is remittances, GDP is gross domestic product, FPI is food production index, ICT is Information communication technology, GDS is gross domestic savings, DCPS is domestic credit to the private sector, CORR is the level of corruption, POL is political stability, RQ is regulatory quality, VA is Voice and accountability, RL is rule of law and GE is government effectiveness. NA is not applicable, NSA is not specifically applicable, NS is negative synergies, PS is positive synergies, TCP is threshold for complementary policies and GT is governance threshold.

From the rural perspective as indicated in Table 1, net effects were computed in one governance indicator (regulatory quality) scenario. From a regulatory perspective, the net effect of regulatory quality is 9.66 ([16.56 ×-.667] + [-1.407]). This equation indicates that the mean value of regulatory quality is -.667, the conditional effect of migrant remittances is 16.59 and the unconditional effect of migrant remittances is -1.407. The 6.99 is the minimum governance threshold level that regulatory quality is expected to reach for remittance to independently change its effect on rural access to electricity from negative to positive. Within the context of rural discussions, Tehero (2021) explored how institutional infrastructure, spatial planning, and economic factors impact electricity access in 14 West African nations, using the Hsiao test. Covering data from 2002 to 2016, the study highlighted the role of government efficacy and regulatory quality in boosting energy access. Ahlborg et al. (2015) examined household electricity use, highlighting that both institutional quality and democratic governance—particularly the rule of law and corruption control—substantially impact energy distribution and rural electrification outcomes.

From Table 1, the interactive regressions indicate that corruption, voice and accountability and government effectiveness exhibit negative synergies with remittances to influence rural access to electricity. From Table 2, GDP has a significant negative effect on access to electricity in urban SSA which is counterintuitive. This could be explained from the point that national incomes are directed to other needs like health, food and security at the expense of electricity access. The unconditional effect of control of corruption has a negative effect on urban access to electricity as evident in Figure 2. This stems from when corruption control is directed towards other service provisions other than electricity access in urban settings. Moreover, in urban SSA, corruption has positive synergies with remittances to enhance access to electricity. Also, the study computes the net effect based on urban areas in SSA countries. It can be inferred from Table 2 that the net effect of political stability, the computed net effect is 3.30 ([-3.3×-0.459] + [1.781]) in the third column. It is clear that the mean figure of political stability is -0.459 whereas the conditional and unconditional effects of migrant remittances are -3.3 and 1.781 respectively. The 3.30 is the governance threshold at which political stability needs complementary policies such as financial inclusion policies, infrastructural development programmes and targeted incentives that collectively support grid expansion and off-grid alternatives. From the fifth specification in Table 2, for voice and accountability, the computed net effect is 1.76 ([-1.691 ×-.56] + [0.816]). The mean value of voice and accountability is -0.56 whereas the conditional and unconditional effects of remittances are -1.691 and 0.816 respectively. This implies that when voice and accountability reach a governance threshold of 1.76, it calls for complementary policies particularly transparent financial system, technology and innovation to enhance the impact of remittances on access to electricity. The graph representing the net effects is shown as Appendix V. According to Sarkodie and Adam (2020), improving the political system prevailing in Sub-Saharan Africa is essential to guaranteeing access to contemporary electricity. These findings on political stability are consistent with their findings. Similarly, Aluko et al. (2023) restate that governance has a favourable effect on power access.

3.2. Geographical Net Effect Decomposition

3.2.1 Geographical decomposing net effects in the nexuses between remittances, governance and access to electricity

Let y= access to electricity, x= average of governance indicators

Urban Areas
Sixth specification (political stability) of Table 1: y= -3.3x + 1.781 (when x= 0.46, y= 3.30)
Threshold for matching policy: when y=0, x= 0.54 (1.781/3.3)

Tenth specification (voice and accountability) of Table 1: y= -1.691x + 0.816 (when x= 0.56, y= 1.76)
Threshold for matching policy: when y= 0, x= 0.48 (0.816/1.691)

Rural Areas
Seventh specification (regulatory quality) of Table 1: y= 16.59x + (-1.407) (when x= 0.667, y= 9.66)
Threshold for matching policy: when y= 0, x= 0.08 (1.407/16.59)

The decomposition analysis also shows that the established threshold range for rural and urban access to electricity is from 1.76 and 9.66 and that of governance is from 0.08 and 0.54. The governance thresholds are below the established policy range as shown as Appendix VI. Once these thresholds for complementary policy are reached (as in the case of political stability and voice and accountability), complementary measures should be implemented to sustain the beneficial impact of migrant remittances on rural and urban energy access. These thresholds are crucial levels of governance indicators. It is important to note that governance quality threshold for voice and accountability is within the policy range while that of political stability is beyond the policy range. On the other hand, regulatory quality has a minimum threshold to arrive at a positive impact of remittances on access to electricity. To sustain and improve the positive effects of remittances on access to energy in urban areas, more policy measures are required to reach these governance quality levels. This perspective highlights that improving access to power through remittances is insufficient, even though governance is crucial. Reaching specific governance indicator thresholds enables the creation of tailored policies that enhance regulatory efficacy, market stability, and infrastructure development (Awad et al., 2024). Furthermore, rural households that receive remittances could be eligible for tax incentives from SSA governments to link to the national grid (Guermond, 2022). By changing remittance inflows from merely sustaining consumption to contributing developmental capital, such a strategy will expand access to power in underserved areas. Additionally, the government should lower the cost of electrical installation equipment for low-income homes in SSA's metropolitan areas.

3.3 Robustness Check

To check the robustness of the panel, we use Tobit estimation. When the outcome variable in the model is censored, or has a limited range or boundary, as occurs when observations are truncated at a certain value (e.g., zero or an upper limit), it is imperative to use a Tobit estimation for panel data as a robustness check. This stems from the fact that system-GMM is unable to explain why access to power is restricted for both rural and urban populations, it may produce bias and consistent results in this situation. Table 2 displays the Tobit robustness figures for the individual governance indicators in enhancing remittances to affect access to electricity in rural and urban SSA. From Table 3 as expressed out of the third specification, the net effect on access to electricity in SSA countries from the importance of remittances in modulating the influence of political stability on access to electricity is 0.67 ([-0.56 ×-0.459] + [0.415]) in rural SSA. As part of the estimation, the mean value of political stability is -0.459, the conditional effect of migrant remittances is -0.56 and the unconditional effect of migrant remittances is 0.415.

In light of determining the threshold points, the decomposition of the net effect is as follows:
The fifth specification (political stability) of Table 2: y= -0.56x + 0.415 (when x= -0.459, y= 0.67)
Threshold for complementary policy: when y=0, x= 0.74 (0.415/0.56).

Table 3: Remittances, Governance and Rural Access to Electricity

		CORR	POL	RQ	VA	RL	GE
	RPAE	RPAE	RPAE	RPAE	RPAE	RPAE	RPAE
GDP	1.674**	1.377*	1.332	1.372	1.529*	1.158	0.877
	(0.818)	(0.813)	(0.819)	(0.826)	(0.813)	(0.799)	(0.814)
FPI	0.011	0.015	0.011	0.012	0.01	0.013	0.014
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
DCPS	0.172*	0.181**	0.185**	0.177**	0.138	0.185	0.138*
	(0.088)	(0.087)	(0.087)	(0.087)	(0.085)	(0.082)	(0.084)
ICT	0.088	0.079***	0.082***	0.084***	0.086***	0.077	0.086***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)
GDS	0.248***	0.243***	0.249***	0.244***	0.245***	0.235	0.263***
	(0.094)	(0.092)	(0.094)	(0.093)	(0.091)	(0.09)	(0.089)
RMIT	0.218	0.018	0.415**	-0.211	0.178	0.185	-0.14
	(0.182)	(0.192)	(0.208)	(0.275)	(0.232)	(0.177)	(0.201)
CORR		6.181					
		(2.989)					
REMIT*CORR		-1.006					
		(0.359)					
POL			4.232**				
			(1.927)				
REMIT*POL			-0.56**				
			(0.26)				
RQ				5.38*			
				(3.082)			
RMIT*RQ				-1.002**			
				(0.493)			
VA					8.89***		
					(2.855)		
REMIT*VA					-0.122		
					(0.389)		
RL						11.314	
						(2.713)	
REMIT*RL						-1.266	
						(0.316)	
GE							12.551***
							(2.997)

REMIT*GE							-1.273*** (0.359)
Net Effect	NSA	NA	0.67 (TCP)	NA	NA	NA	NA
Constant	-2.031*** (6.039)	2.866 (6.253)	0.919*** (6.056)	2.649*** (6.499)	4.769 (6.332)	7.14 (6.164)	10.659 (6.548)
sigma_u	16.445*** (2.261)	15.367 (2.301)	15.645*** (2.224)	15.294*** (2.223)	14.652*** (2.002)	13.851*** (1.971)	13.739*** (1.964)
sigma_e	14.273 (0.664)	14.16 (0.668)	14.185*** (0.663)	14.277*** (0.669)	14.205*** (0.657)	13.976*** (0.65)	14.053*** (0.653)
Mean dependent var	19.193	19.193	19.193	19.193	19.193	19.193	19.193
Number of obs.	280	280	280	280	280	280	280
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SD dependent var	25.190	25.190	25.190	25.190	25.190	25.190	25.190
Chi-square	44.442	54.622	52.645	50.214	59.775	73.190	71.145
Akaike crit. (AIC)	2394.557	2389.791	2391.931	2393.493	2387.963	2376.078	2378.197

Source (s): Authors' own work

*** *p<.01,* ** *p<.05,* * *p<.* ***, ** and * Significance levels at 1%, 5% and 10%, respectively. sigma_u is the standard deviation of the **unobserved individual-specific effects and** sigma_e is the standard deviation of the **idiosyncratic error term**. Values in parathesis are standard errors. RPAE is rural population access to electricity, UPAE is urban population access to electricity, RMIT is remittances, GDP is gross domestic product, FPI is food production index, ICT is Information communication technology, GDS is gross domestic savings, DCPS is domestic credit to the private sector, CORR is the level of corruption, POL is political stability, RQ is regulatory quality, VA is Voice and accountability, RL is rule of law and GE is government effectiveness. NA is not applicable, NSA is not specifically applicable, NS is negative synergies, TCP is threshold for complementary policies.

Table 4: Remittances, Governance and Urban Access to Electricity

		CORR	POL	RQ	VA	RL	GE
	UPAE	**UPAE**	**UPAE**	**UPAE**	**UPAE**	**UPAE**	**UPAE**
GDP	0.995	0.995	0.645	0.43	0.88	0.585	0.224
	(1.08)	(1.08)	(1.079)	(1.07)	(1.074)	(1.055)	(1.082)
FPI	0.114***	0.114***	0.112***	0.115***	0.111***	0.111	0.115***
	(0.033)	(0.033)	(0.032)	(0.032)	(0.033)	(0.032)	(0.032)
DCPS	0.272***	0.272***	0.311***	0.253***	0.237**	0.254	0.219**
	(0.098)	(0.098)	(0.262)	(0.098)	(0.102)	(0.095)	(0.1)
ICT	0.094***	0.094***	0.092***	0.092***	0.1***	0.083	0.094***
	(0.033)	(0.033)	(0.033)	(0.032)	(0.033)	(0.032)	(0.032)
GDS	0.434***	0.434***	0.441	0.464***	0.44***	0.475	0.476***
	(0.112)	(0.112)	(0.112)	(0.11)	(0.112)	(0.109)	(0.109)
RMIT	-0.002	-0.002	0.331	-0.794**	-0.091	0.101	-0.36
	(0.245)	(0.245)	(0.262)	(0.351)	(0.293)	(0.226)	(0.26)
CORR		1.278					
		(3.294)					
REMIT*CORR		-0.652					
		(0.463)					
POL			3.94*				
			(2.238)				
REMIT*POL			-0.704**				
			(0.34)				
RQ				7.474**			
				(3.409)			
RMIT*RQ				-2.087***			
				(0.631)			
VA					3.775		
					(3.324)		
REMIT*VA					-0.528		
					(0.5)		
RL						7.168	
						(31.)	
REMIT*RL						-1.676	
						(0.41)	
GE							8.99**
							(3.525)

REMIT*GE							-1.638***
							(0.466)
Net Effect	NSA	NA	NA	NS	NA	NA	NA
Constant	32.296***	32.296***	34.997***	38.934***	35.436***	37.232	41.544***
	(7.828)	(7.828)	(7.435)	(7.966)	(7.901)	(7.751)	(8.356)
sigma_u	12.68***	12.68***	12.447***	11.966***	12.772***	11.781	11.846***
	(2.024)	(2.024)	(1.95)	(1.94)	(1.987)	(1.907)	(1.909)
sigma_e	19.407***	19.407***	19.33***	19.182***	19.408***	19.019	19.13***
	(0.895)	(0.895)	(0.887)	(0.883)	(0.892)	(0.875)	(0.879)
Mean dependent var	59.648	59.648	59.648	59.648	59.648	59.648	59.648
Number of obs.	280	280	280	280	280	280	280
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SD dependent var	27.191	27.191	27.191	27.191	27.191	27.191	27.191
Chi-square	66.261	66.261	70.958	78.833	66.330	85.365	82.108
Akaike crit. (AIC)	2532.686	2532.686	2529.595	2523.434	2533.148	2518.225	2521.464

Source (s): Authors' own work

*** p<.01, ** p<.05, * p<. ***, ** and * Significance levels at 1%, 5% and 10%, respectively. sigma_u is the standard deviation of the unobserved individual-specific effects and sigma_e is the standard deviation of the idiosyncratic error term. Values in parathesis are standard errors. RPAE is rural population access to electricity, UPAE is urban population access to electricity, RMIT is remittances, GDP is gross domestic product, FPI is food production index, ICT is Information communication technology, GDS is gross domestic savings, DCPS is domestic credit to the private sector, CORR is the level of corruption, POL is political stability, RQ is regulatory quality, VA is Voice and accountability, RL is rule of law and GE is government effectiveness. NA is not applicable, NSA is not specifically applicable, NS is negative synergies, TCP is threshold for complementary policies

4. Conclusion and Implications

The study concentrates on 40 SSA nations employing 5 years non-overlapping intervals from 1990 to 2022 by delving into how governance influences migrant remittances to affect access to electricity in rural and urban areas. Based on the System-GMM analysis, migrant remittances increase access to energy in both rural and urban areas however with unequal impacts. By implication, urban households tend to benefit more from the flow of remittances in SSA countries compared to their rural counterparts. On the part of the interacted regressions, migrant remittances mix with corruption, regulatory quality and government effectiveness to produce negative synergies on urban access to electricity. From Table 1, the unconditional effects of remittances with respect to corruption, regulatory quality and government effectiveness have negative influence on rural access to electricity. The results show that migrant remittances do not increase access to power in rural Sub-Saharan Africa (SSA), particularly when there is inadequate governance. Remittances are diverted from energy infrastructure to consumption or small-scale investments due to institutional inefficiencies, corruption, and poor regulatory quality. This exacerbates socioeconomic inequalities and rural energy poverty. To counteract this detrimental effect, a regulatory quality threshold of 9.66 is required. The point is that without efficient government, remittances by themselves are insufficient. To guarantee that remittances promote rural electrification, governments must strengthen regulatory frameworks, combat corruption, and decentralized energy supply.

Remittances, on the other hand, have a favourable impact on access to power in urban SSA, especially in areas with robust anti-corruption measures. Remittances have a greater developmental impact when there is a synergy created by good governance. This suggests that urban households can make better use of remitted monies for energy access when corruption is low. However, this beneficial effect is diminished by political unpredictability and a lack of public accountability. Political stability requirements are still above the current policy levels, even while voice and accountability standards are reachable. This implies that while good governance is important, it is not enough, and that the majority of remittances can go to wealthier households, thereby escalating inequality. Governments should supervise financial institutions and lower transaction fees to encourage openness in remittance channels in order to address these issues. Results will be further enhanced by streamlining remittance processes and setting up digital channels for monitoring and feedback. Furthermore, tax breaks or matched savings plans can promote the purchase of renewable energy equipment like solar panels or mini-grids. Remittances could also be directed into subsidised energy programs with the aid of public-private partnerships, particularly for low-income households. SSA nations may more effectively use migrant remittances to increase access to power, lower energy poverty, and promote inclusive development in both rural and urban regions by bolstering governance and putting complementary policies into place.

Imminent studies can advance the existing outcomes by re-examining the problem statement from a comparative standpoint from both developed and emerging nations. A caution in the GMM estimation approach that removes comparison effects because of their potential to cause endogeneity due to their link with the lagged outcome variables is expanded upon by this proposal. It is also critical to keep in mind that a comparison analysis between developed and global south economies may be considered in future studies. Future research should examine the impact of remittances on access to energy with a moderating effect from governances by taking into account sub-regional groups according to income levels.

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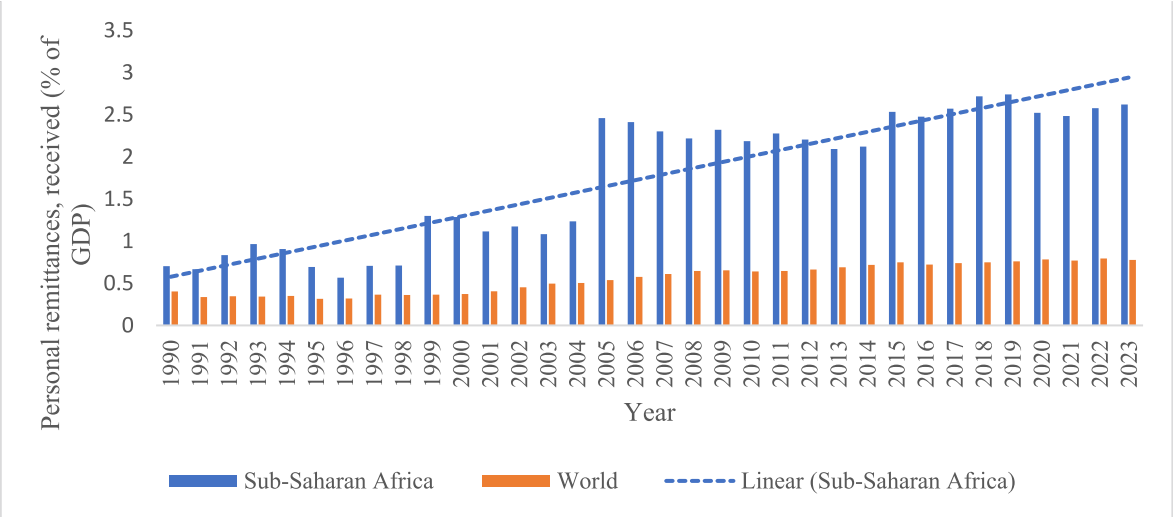
Appendix I – Variable Definition

Variable	Definition	Expected Sign	Source
Rural access to electricity (RPAE)	Percentage of population with access to electricity		World Bank (WDI)
Urban access to electricity (UPAE)	Percentage of population with access to electricity		World Bank (WDI)
Remittances (RMIT)	Remittances as percentage of GDP	+	World Bank (WDI)
Gross domestic product (GDP)	Sum of all value added by all resident producers in an economy	+	World Bank (WDI)
Food production index (FPI)	Changes in the production of food commodity in a given year relative to base year	+/-	World Bank (WDI)
Information Communication and Technology (ICT)	Measured by internet users per 100 people, mobile cellular subscription rate per 100 people, and fixed broadband subscription per 100 people.	+	World Bank (WDI)
Gross domestic savings (GDS)	GDP minus final consumption expenditure	+	World Bank (WDI)
Domestic credit to private sector (DCPS)	Financial resources provided to the private sector by financial corporations	+	World Bank (WDI)
Corruption (CORR)	the extent to which public power is exercised for private gain, including both petty and grand forms of corruption	-	World Bank (WDI)
Political stability (POL)	the likelihood of political instability and violence, including terrorism	+	World Bank (WDI)
Regulatory quality (RQ)	the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	+	World Bank (WDI)
Voice and accountability (VA)	the extent to which a country's citizens can participate in selecting their government, as well as their freedom of expression, freedom of association, and free media	+	World Bank (WDI)
Rule of Law (RL)	the extent to which agents have confidence in and abide by the rules of society	+	World Bank (WDI)
Government effectiveness (GE)	the quality of public services, the quality of the civil service, and the degree of its independence from political pressures	+	World Bank (WDI)
Governance index (GOV)	Institutional governance (corruption-control and the rule of law); Economic governance (government effectiveness and regulatory quality) and Political governance (political stability/no violence and 'voice and accountability).	+	World Bank (WDI)

Source (s): Authors' own work

Appendix II – Trends of Remittances in sub-Saharan Africa (1009-2023)



Source (s): Authors' own work

Figure 1: Trends of remittances as a percentage of Gross Domestic Product in SSA and the World

Appendix III - Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Rural population access to electricity	308	19.029	24.692	.622	99.78
Urban population access to electricity	308	58.645	27.688	1	99.999
Remittances	308	3.388	6.83	.114	83.968
Gross domestic product	308	6.241	1.463	1.44	9.764
Food production index	308	62.039	38.693	1.13	171.396
Information Communication and Technology	308	32.261	41.315	.115	179.353
Gross domestic savings	280	13.979	16.847	-33.255	74.364
Domestic credit to private sector	308	16.791	18.697	.424	124.822
Corruption	308	-.0625	.693	-1.935	1.83
Political stability	308	-.459	.954	-2.976	1.748
Regulatory quality	308	-.667	.628	-2.714	1.683
Voice and accountability	308	-.56	.739	-1.953	.967
Rule of Law	308	-.676	.684	-1.985	.956
Government effectiveness	308	-.755	.639	-1.988	.984
Governance index	308	0	1	-2.639	2.313

Source (s): Authors' own work
Std. Dev. is standard deviation, Min is Minimum, Max is Maximum

Appendix IV – Correlation

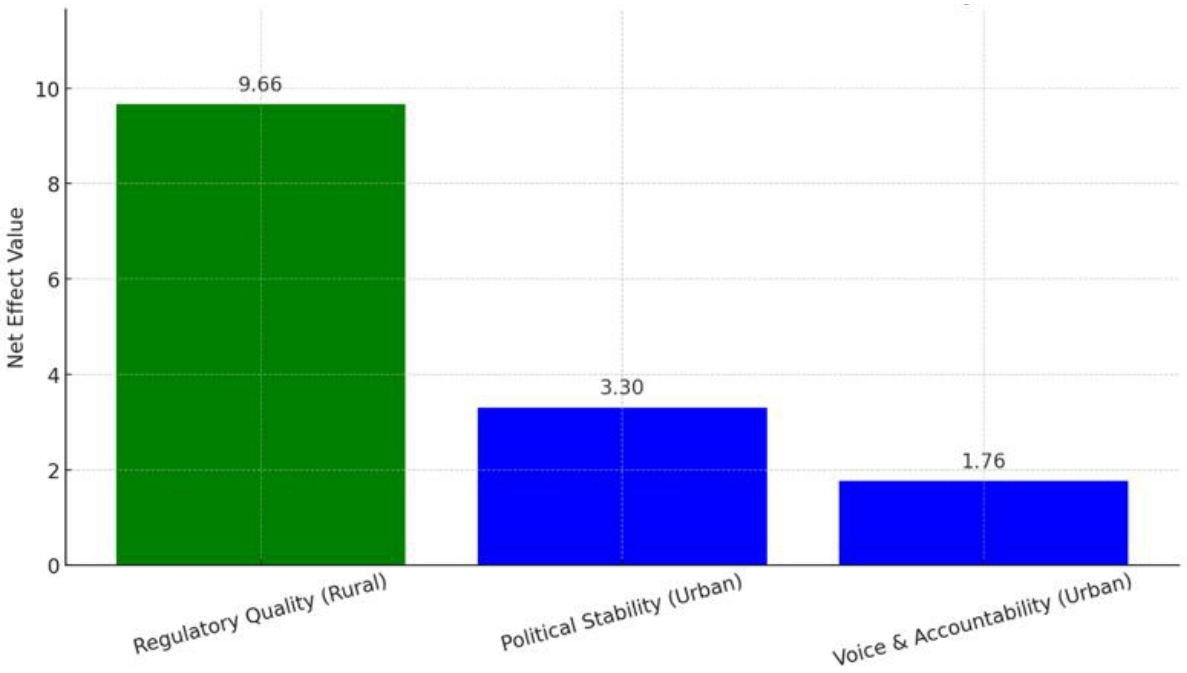
Variables	RPAE	UPAE	CORR	DCPS	FPI	GDP	GEFF	GDS	ICT	RMIT	POL	RQ	RL	VA
RPAE	1.000													
UPAE	0.535	1.000												
	(0.000)													
CORR	0.423	0.159	1.000											
	(0.000)	(0.005)												
DCPS	0.516	0.336	0.404	1.000										
	(0.000)	(0.000)	(0.000)											
FPI	0.045	0.146	0.066	0.044	1.000									
	(0.434)	(0.010)	(0.249)	(0.440)										
GDP	0.377	0.248	0.344	0.356	0.091	1.000								
	(0.000)	(0.000)	(0.000)	(0.000)	(0.111)									
GEFF	0.487	0.254	0.774	0.548	0.040	0.438	1.000							
	(0.000)	(0.000)	(0.000)	(0.000)	(0.485)	(0.000)								
GDS	0.091	0.311	-0.074	0.006	-0.009	0.232	0.030	1.000						
	(0.130)	(0.000)	(0.215)	(0.921)	(0.885)	(0.000)	(0.621)							

ICT	0.352	0.296	0.204	0.369	0.083	0.398	0.235	0.051	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.146)	(0.000)	(0.000)	(0.394)					
RMIT	0.042	-0.078	0.118	-0.009	0.011	-0.097	0.009	-0.403	-0.014	1.000			
	(0.464)	(0.172)	(0.038)	(0.871)	(0.854)	(0.088)	(0.871)	(0.000)	(0.807)				
POL	0.381	0.232	0.658	0.298	-0.021	0.367	0.647	0.150	0.121	0.105	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.714)	(0.000)	(0.000)	(0.012)	(0.033)	(0.065)			
RQ	0.396	0.219	0.679	0.476	0.045	0.323	0.824	0.016	0.227	-0.007	0.603	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.432)	(0.000)	(0.000)	(0.790)	(0.000)	(0.906)	(0.000)		
RL	0.449	0.221	0.809	0.436	0.012	0.338	0.832	0.022	0.183	0.125	0.764	0.809	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.829)	(0.000)	(0.000)	(0.711)	(0.001)	(0.028)	(0.000)	(0.000)	
VA	0.447	0.175	0.692	0.501	0.040	0.254	0.696	-0.099	0.239	0.091	0.625	0.681	0.753	1.000
	(0.000)	(0.002)	(0.000)	(0.000)	(0.479)	(0.000)	(0.000)	(0.098)	(0.000)	(0.113)	(0.000)	(0.000)	(0.000)	

Source (s): Authors' own work

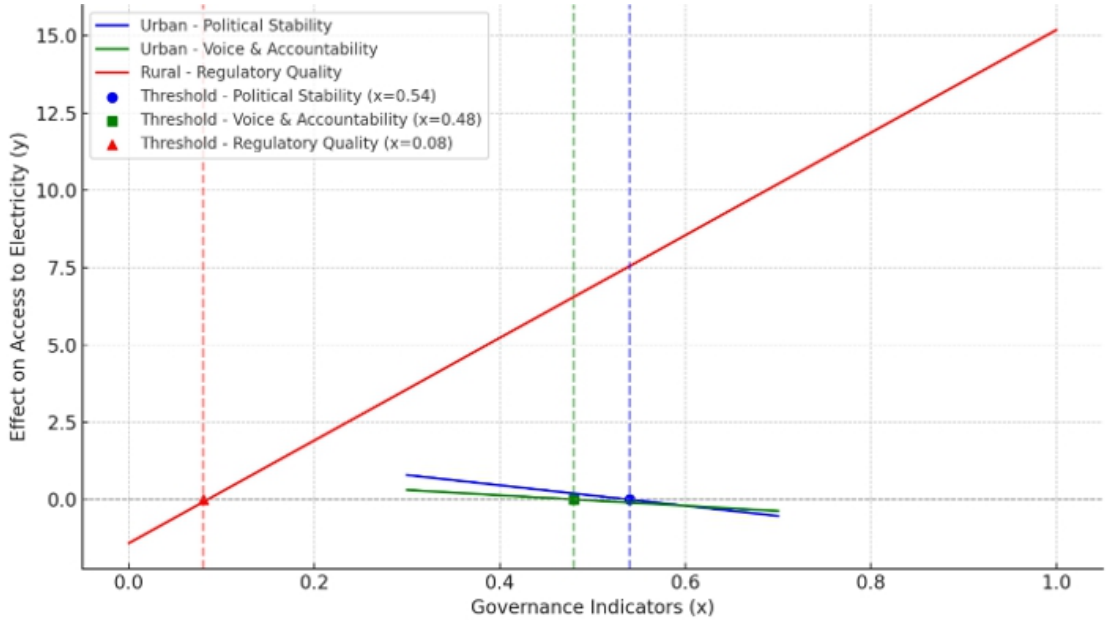
RPAE is rural population access to electricity, UPAE is urban population access to electricity, RMIT is remittances, GDP is gross domestic product, FPI is food production index, ICT is Information communication technology, GDS is gross domestic savings, DCPS is domestic credit to the private sector, CORR is the level of corruption, POL is political stability, RQ is regulatory quality, VA is Voice and accountability, RL is rule of law and GE is government effectivenes

APPENDIX V – Net Effects of Governance Indicators on Remittances and Electricity Access



Source (s): Authors' own work

APPENDIX VI – Governance Threshold for Matching Policies to Enhance Access to Electricity



Source (s): Authors' own work