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Abstract

This paper investigated the long-run relationship between gross domestic product, access to electricity, and remittances within the multivariate framework in Kenya using the data for the period 1987-2018. The autoregressive distributed lag (ARDL) bounds test was used to investigate the long-run relationship. Causality between variables was investigated by use of the Granger causality method. The bounds test indicated that there is cointegration when gross domestic product, electricity access, and remittances are dependent variables. The long-run estimation of coefficients suggests that electricity access and remittances have significant positive impact on economic growth in Kenya in the sample period. Causality analysis provides evidence that there is unidirectional Granger causality running from gross domestic product to electricity access and not vice versa and from gross domestic product to remittances and not vice versa. There was no causality between remittances and electricity access. The policy implications of the paper suggest that the government and other companies concerned should enhance electricity access and encourage inflows of remittances as these contribute positively to economic growth in Kenya.

Keywords: Economic growth; Electricity access; Remittances ARDL; Kenya.

1. INTRODUCTION

Energy plays a major role in the economic development of a country. It is one of the key factors for production. It is an essential commodity for most human activities, such as serving as source of fuel for transport, source of light, and power for household appliances and industrial production. All these make energy play a crucial role in the socioeconomic development of the country. However, in the traditional economic growth theories, energy is not included among the factors of production. Energy is taken as an intermediate input in the production function. Electricity, a component of energy, is one of the renewable and clean energies, with minimal negative health impacts. It is a major factor in economic development of the country and very important in achieving the Millennium Development Goals. Electricity is a key source of energy in both industrial and agricultural sectors of the economy. It also plays a key role in the health, education, and domestic sectors of the economy. It enables the low-income households in poor countries to engage in income-generating projects, which can facilitate them to move away from poverty. Poor access to modern, affordable, and clean energy hinders the economic development of the country. Without access to modern energy, the country will be pushed further to poverty (Attigah and Mayer-Tasch, 2013).

Much progress has been made all over the world in connecting people to reliable supplies of electricity, but still, some regions are yet to be supplied with adequate electricity (Stern *et al.*, 2017). In sub-Saharan Africa (SSA), around 70% of people have no access to electricity (Lee *et al.*, 2017). Due to this, electricity access is one of the top concerns for policy makers in Africa and other developing countries. However, there is little empirical evidence on the relationship between electricity access and economic development.

Kenya's electricity access by 2018 stood at 75%, which is the highest among the East African countries. This is due to many electrification projects that have been undertaken by Kenya Power, such as the last mile connectivity project and Global Partnership on Output-Based Aid (GPOBA), which targets the urban informal sector and low-income areas in the rural areas. There has been a steady increase in electricity access in Kenya from 32% in 2013 to around 75% in 2018, due to increased investment in distribution network and in renewable energy production. Kenya Power aims at achieving universal electricity access by 2020. Kenya has been listed among the countries where much gain has been made in electricity access especially for lighting, cooking, and boosting business operations (World Bank, 2019a). In spite of these gains, not many studies have been done to show the relationship between economic growth and electricity access in Kenya. This study will add knowledge to the link between electricity access and economic development, which is very important for policy makers within the energy sector and the government at large.

Just as energy, capital is also an important input that contributes to the economic growth of a country. Migrant remittances, as part of financial inflows to a country, are becoming increasingly important sources of foreign exchange in developing countries. It has attracted a lot of attention from academicians, policy makers, and bankers. Remittance is money sent by a person in a foreign land to his or her home country. Due to the huge sums involved, remittances are now being recognized as an important contributor to the country's growth and development. Remittances contribute to the economic development of a country through poverty reduction, promoting human development, development of the financial sector, and stabilizing the foreign exchange flow.

Remittances to low- and middle-income countries reached $529 billion, in 2018, an increase of 9.6% over the previous period, which recorded $483 billion in 2017. Global remittances that include flows to advanced countries reached $689 billion in 2018, up from $633 billion in 2017 (World Bank, 2019a). Kenya's remittances, in 2018, reached $2.72 billion as compared to $1.962 billion in 2017, an increase of 38% (World Bank, 2019a). In spite of the increasing trend of remittances to various countries all over the world, there is scarcity of empirical research on the impact and causal effect of remittances on economic growth.

The aim of this paper is to investigate the link between electricity access, economic growth, and remittances within a multivariate framework.

This paper is organized as follows: Section 1.0 provides an introduction to the paper, section 2 discusses the literature review, section 3 presents the methodology of the paper, section 4 presents empirical findings, and lastly, section 5 provides the summary of the paper.

2. LITERATURE REVIEW

2.1. Theoretical Literature

Theories of economic growth suggest various hypotheses on variables that explain the economic growth of a country. The Classical Theory by Adam Smith suggests that economic growth is driven by productivity of labor, trade that enables specialization, and the role of markets in determining supply and demand. The neoclassical model by Solow and Swan highlights that economic growth of a country is determined by the proportion of GDP that is saved and technological progress that increases productivity. The Harrod–Domar model states the condition for steady economic growth. They argue that economic growth depends on the savings of the country. Savings facilitate investment and investment increases growth. The endogenous growth model by Romar and Lucas emphasizes the role of human capital in determining economic growth. Employees with greater knowledge, education, and training impact positively on technological progress. Technological progress increases productivity of both capital and labor and hence the economic growth of the country.

From this discussion on the theories of economic growth, energy and remittances do not enter directly into the growth models. However, energy powers the production process and enhances education, health, technology, and the distribution of goods and services. Energy, especially, clean energy is expected to positively impact on economic growth. Remittances are a source of foreign exchange. Remittances increase savings of a country; hence, they positively affect capital accumulation and finally the economic growth of a country. Remittances finance the growth of various projects within an economy and this is enhancing to economic growth. Remittances finance education and the health of a country.

Remittances also contribute to financial development of a country. Remittances can have multiplier effects in the economy. Any dollar spent on consumption of goods will raise sales for goods and services. This will generate production for the same goods and employment will increase as well (Loweli and Garza, 2000). The Pure Altruism Theory of remittances argues that migrants send back home money to cater for the welfare of their relatives. The pure self-interest argues that migrants send back money home to finance various investment projects, such as purchase of durable assets. All these are key to the economic development of a country.

2.2. Empirical Literature Review

2.2.1. Electricity Access and Economic Growth
Guyuye (2017) in the study on effect of electricity access on education gave evidence that electricity access improves educational attainment in Kenya. The study used proximity to preexisting transmission lines as a measure of electricity access. The results from the study indicated that the average years of schooling for those with electricity access to be 4.1 higher than those without electricity access. The study applied the two-stage least squares (2SLS) method to analyze the relationship between electricity access and educational attainment. The regression results suggest that electricity access improves educational attainment

Rehman and Deyuan (2018) carried out a study on the link between economic growth, electricity access, energy use, and population growth in Pakistan using the autoregressive distributed lag model. The evidence from the results suggested that electricity access in the rural areas had a negative effect on economic growth.

Stern, Burke and Bruns (2017), in their literature review of the impact of electricity access on development, found that electricity use and access strongly and positively affect economic development. This review mainly focused on regions of the world with lowest levels on electrification and electricity use especially in SSA.

Rafal (2014) investigated the relationship between electricity consumption and economic growth in Poland using data for the period 2000-2012. The study used the production function with gross fixed capital, electricity consumption, and total employment as factors of production. Causality was investigated by use of the Granger causality method. The results indicated bidirectional causality between electricity consumption and economic growth in Poland. Further results suggested bidirectional causality between capital and economic growth.

Ogundipe (2013), using data for the period 1980-2008, investigated the relationship between electricity consumption and economic growth for Nigeria. The study applied three methods of analysis. Johansen and Juselius' (1990) cointegration test was used to investigate existence of cointegration between the variables. The vector error correction method was used to investigate the impact of electricity consumption on economic growth, while the Granger causality method was applied to show the direction of causality between the two variables. The results of the study found that there is cointegration between electricity use and economic growth; electricity consumption significantly determines economic growth, and there is bidirectional causality between electricity consumption and economic growth in Nigeria.

From the literature review on electricity access and economic growth, it can be observed that there is no consensus on both the effect of electricity access on economic growth and the causality results between the two variables. There are also very few studies that have been done on the relationship between electricity access and economic growth.

2.2.2. Remittances and Economic Growth
Imad (2018) investigated the link between remittances financial development, institutional quality, and economic growth for 14 Middle East and North African countries. This study used unbalanced panel data for the period 1982-2016. Two-stage least squares and instrumental variables methods were used to estimate the relationship between the variables. Results from this study showed existence of complementary relationship between financial development and remittances to ensure economic growth. Further, the results indicated that remittances promote economic growth in countries with developed financial systems and a strong institutional environment.

Abu *et al.* (2012) using data for the period 1975-2006 and the Granger causality method under a VAR studied the causality between remittances and economic growth in Bangladesh, India, and Sri Lanka. The results showed that there is unidirectional causality running from remittances to economic growth in Bangladesh, no causality between the two variables in India, and bidirectional causality between remittances and economic growth in Sri Lanka. Meyer and Adela (2017) found that remittances impact positively on economic growth.

Meyer and Adela (2017)—using a panel data set of six high remittance-receiving countries, Albania, Bulgaria, Macedonia, Moldova, Romania, and Bosnia Herzegovina, during the period 1999-2013—studied the role of remittances on economic growth. The study used the fixed effect model, and results suggest that remittances significantly and positively determine economic growth.

Ondienga *et al.* (2017) in their study on the effects of foreign remittances on selected macroeconomic variables in east African community member countries found that foreign remittances through their impact and dynamic multiplier effects affect positively consumption, investment, imports, and output. This study used panel data for the period 1985-2014 and applied the 2SLS method of estimation.

Ocharo (2014) studied the effect of remittances on economic growth for Kenya. Using data for the period 1970-2010 and the ordinary least squares method of estimation, the study found that remittances positively determine economic growth in Kenya.

Misati, Kamau and Nassir (2019), in their study on effects of remittances on financial development in Kenya using quarterly data for the period 2006-2016 and the autoregressive distributed lag (ARDL) method for investigating existence of long-run relationships, found that remittances affect financial development positively in Kenya. Higher levels of remittances provide recipients opportunities to open bank accounts, increase their savings, and access other bank services. Further, the study found that there is cointegration between remittances and economic growth in Kenya.

Bett (2013) investigated the impact of diaspora remittances on economic growth of Kenya using the panel data for the period 2003-2012. They used the multiple regression model, and study findings show that diaspora remittances drive economic growth in Kenya.

Amugune (2018), using data for the period 2008-2017 and the ordinary least square method of estimation, found that diaspora remittances and interest rates do not significantly affect economic growth in Kenya.

Yero (2009) investigated the effect of remittances on economic growth in SSA. Using a sample of 28 SSA countries and data for the period 1980-2004 and a 2SLS instrumental variable estimation method, the results suggest that remittances do not have direct positive impact on economic growth in SSA. However, remittances may have an indirect positive effect on economic growth through other channels such as investment or through improved education of recipients of remittances.

From the earlier mentioned studies, it can be observed that there is no consensus on both the effects of foreign remittances on economic growth and on causality between remittances and economic growth results.

This study aimed at investigating the relationship between economic growth, electricity access, and remittances using data for the period of 1987-2018. The autoregressive distributed lag model was used and the Granger causality method was also employed.

3. METHOD(S)

The aim of this paper was to analyze the relationship between economic growth, electricity access, and remittances in Kenya using the data for the period 1987 to 2018. This paper used the ARDL model or bounds test for cointegration to investigate both the long-run and short-run relationship between economic growth, electricity access, remittances, and other control variables. Pesaran *et al.* (2001) provides the ARDL bounds approach to test for cointegration between variables. The ARDL model is used only when the variables in the model are I(0) and I(1) in order of integration or a combination of both (Nkoro and Uko, 2016). This means that the respective series become stationary at levels or after their first differences. None of the variables should be I(2). One of the advantages of the ARDL model is that it is relatively more efficient in small and finite sample sizes (Pesaran *et al.*, 2001). The ARDL model also provides unbiased long-run estimated parameters.

The relationship between the variables considered in this paper is improved from the traditional production function:

$$Q = Af(K,L) \tag{1}$$

Where Q (GDP) is economic growth, K and L are quantities of capital and labour inputs, respectively. To answer the research objectives of this paper, the production function specified in Equation (1) is augmented with the variables of interest such as electricity access and remittances. Other variable that determines economic growth also included is trade. The function was modified as:

$$GDP = Af \text{ (capital, labor, access, remittances, trade)} \tag{2}$$

Where GDP is Kenya's annual economic growth per capita, access (AC) represents percentage of people who have access to electricity to total population, remittances (REM) are remittances, which is money sent by Kenyans in foreign countries to their relatives in Kenya per annum, trade (TR) is sum of exports and imports expressed divided by GDP, labor (LB) represents Kenyans aged 15-64 years working expressed as a percentage of total population, while capital (K) represents Kenya's gross capital formation

The general form of the ARDL model is expressed as:

$$GDP_t = \beta_0 + \sum_{i=1}^{p} \delta_i GDP_{t-i} + \sum_{i=0}^{q} \lambda_i X_{t-1} + e_{ti}. \tag{3}$$

Where X is a vector of all the explanatory variables, which are either I(0) or I(1), or cointegrated. β, δ, and λ are parameters to be estimated, while p and q are optimal lag orders and e_{ti} is a vector of error terms assumed to have zero mean, constant variance, and are independent.

The following ARDL model was estimated in order to test for cointegration between the variables: economic growth, access to electricity, foreign direct investment, remittances, and foreign exchange rate in Kenya.

$$
\begin{aligned}
\Delta lnGDP_t = a_0 &+ \sum_{i=1}^{p} \beta_i \Delta lnGDP_{t-i} + \sum_{i=0}^{q1} \delta_i \Delta lnAC_{t-i} + \sum_{j=0}^{q2} \alpha_j \Delta lnK_{t=j} + \sum_{k=0}^{q3} d_k \Delta lnLB + \sum_{m=0}^{q4} \gamma_m \Delta lnREM \\
&+ \sum_{r=0}^{q5} \pi_r \Delta lnTR + \sigma_1 lnGDP_{t-1} + \sigma_2 lnAC_{t-1} + \sigma_3 lnK_{t-1} + \sigma_4 lnLB_{t-1} + \sigma_5 lnREM_{t-1} + \sigma_6 lnTR_{t-1} + e_t
\end{aligned} \tag{4}
$$

The coefficients $\beta_i, \delta_i, \alpha_j, d_k, \gamma_m$, and π_r are short-run dynamic coefficients of the model, σ_i is a long-run parameter of the model, and e_t are white noise errors. To perform the bounds test, the following hypothesis was tested:

H_0: $\sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = \sigma_5 = \sigma_6 = 0$ (the long-run relationship does not exist)
H_1: $\sigma_1 \neq \sigma_2 \neq \sigma_3 \neq \sigma_4 \neq \sigma_5 \neq \sigma_6 \neq 0$ (the long-run relationship exists)

Once the test is done, if one fails to reject the null hypothesis, then one can conclude that there is no cointegration in the series; however, if the null hypothesis is rejected, then one can conclude that there is cointegration in the series.

The calculated F-statistic derived from the Wald test is compared with the critical values of Pesaran *et al.* (2001). If the F-statistic value is lower than the lower bound critical value of Pesaran *et al.* (2001), then it is concluded that there is no long-run relationship between the time series variables considered in the model. If the computed F-statistic value falls between the lower and upper critical values of Pesaran *et al.* (2001), then there is no conclusion made on the relationship between the variables. However, if the estimated F-statistic is above the upper bound critical value of Pesaran *et al.*'s (2001),

one concludes that there is long-run relationship between the variables included in the model. If coin-tegration is established, the conditional ARDL (*p*, *q*1, *q*2, *q*3, *q*4, *q*5) long-run model for the variables will be estimated.

$$InGDP_t = \beta_0 + \sum_{i=1}^{p} \sigma_1 InGDP_{t-i} + \sum_{i=0}^{q1} \sigma_i \ InAC_{t-i} + \sum_{j=0}^{q2} \sigma_j K_{t-j} + \sum_{k=0}^{q3} \sigma_k InLB_{t-k}$$
$$+ \sum_{m=0}^{q4} \sigma_m InREM_{t-m} + \sum_{r=0}^{q5} \sigma_r InTR + e_{it} \tag{5}$$

All variables are as defined earlier. The lag orders *p*, *q*1, *q*2, *q*3, *q*4, and *q*5 were selected using the Akaike Information Criteria (AIC).

To obtain the short-run dynamic parameters, the error correction model was estimated:

$$\triangle GDP_t = a_0 + \sum_{i=1}^{p} \beta_i \triangle InGDP_{t-1} + \sum_{i=0}^{q1} \delta_i \triangle InAC_{t-i} + \sum_{j=0}^{q2} \alpha_j \triangle InK_{t-j} + \sum_{k=0}^{q3} d_k \triangle InLB_{t-k}$$
$$+ \sum_{m=0}^{q4} \gamma_m \triangle InREM_{t-m} + \sum_{r=0}^{q5} \sigma_r \triangle InTR_{t-r} + \lambda ECT_{t-1} \tag{6}$$

Where β_i, δ_i, α_j, d_k, γ_m, and σ_r are short-term parameters, while λ is the error correction coefficient, which shows the speed of adjustment of the dependent variable to its equilibrium value.

3.1.   Data Type, Sources, and Explanation of the Variables

This paper used Kenyan annual time series data for the period 1987-2018. The data was sourced mainly from the World Development indicators (World Bank, 2019b) and Central Bank of Kenya publications.

The key variables included in the model are gross domestic per capita income measured in US dollars, electricity access measured as percentage of the total population that have access to electricity, and remittances measured in US dollars. Other control variables included real foreign exchange rate and foreign direct investment.

4.   RESULTS AND DISCUSSION

4.1.   Descriptive Statistics

To investigate the relationship between GDP, electricity access, and remittances, first the descriptive statistics test was done, which is presented in Table 1.

4.2   Unit Root Tests

As the first step of empirical analysis, unit root tests were done using the Augmented DickeyFuller (ADF) and PP test of Phillips and Perron (1988). Both tests analyze the null hypothesis that the series are nonstationary. The unit root tests were done in order to make sure that all variables are I(0) or I(1) (Chigusiwa *et al.*, 2011). The ARDL model is applicable only for the variables that are I(0) or I(1) or mutually cointegrated. It is not applicable for the series that are I(2) (Ouattara, 2004; Pesaran *et al.*, 2001). All the variables are expressed in natural logarithms. Unit root test results are presented in Table 2.

The AIC was used to select the lag length. According to the results in Table 2, access to electricity was found to be stationary at levels, while the rest of the variables such as gross domestic per capita income, labor, trade, capital, and remittances were stationary at their first differences. The variables were therefore a mix of both I(0) and I(1) levels of integration. With these stationary results, the ARDL bounds test was found appropriate for testing for cointegration between the variables.

Table 1. Descriptive Statistics of the Variables.

	GDP	AC	REM	K	TR	LB
Mean	10.47	2.80	5.41	2.91	3.97	4.2
Median	10.38	2.91	6.25	2.93	3.99	4.2
Maximum	11.96	4.30	7.91	3.13	4.29	4.3
Minimum	8.73	0.83	1.39	2.73	3.59	4.18
Std. Dev.	0.99	0.91	1.84	0.10	0.16	0.046
Skewness	−0.16	−0.25	−0.66	−0.08	−0.51	0.079
Kurtosis	1.95	2.14	2.27	1.95	3.76	1.18
Jarque–Bera	1.62	1.33	3.00	1.49	2.17	4.4
Probability	0.45	0.52	0.22	0.47	0.33	0.11
Sum	335.11	89.69	173.14	93.36	127.30	135
Sum Sq. Dev.	30.58	25.36	104.5820	0.37	0.83	0.068
Observations	32	32	32	32	32	32

Table 2. Unit Root Test Results of the Variables.

	ADF		Phillips–Perron		
Variable	Level	1st Diff.	Level	1st Diff.	Decision
ln(AC)	−3.9**	**−7.05***	−3.89**	−17.8***	I(0)
ln(GDP)	−3.250*	−4.00***	−1.85	−4.013***	I(1)
Ln(K)	−2.55	−5.30***	−2.43	−8.7***	I(1)
LN(LB)	−2.21	−5.263***	−2.15**	−5.45***	I(1)
Ln(Rem)	−3.11	−5.815***	−2.77	−9.8***	I(1)
ln(TR)	−1.9	−5.24**	−2.0	−5.35***	(1)

(***), (**), (*) mean the series is stationary at 1%, 5%, and 10%, respectively; all tests were done with intercepts and trend.

4.3. The ARDL Bounds Test Results

The *F*-statistic tests for the joint null hypothesis that the coefficients of all lagged variables at levels is equal to zero (no long-run relation exists) are presented in Table 3. Each variable was considered as the dependent variable.

The bounds test assumes the null hypothesis, according to which there is no long-run relationship between the variables. The results in Table 3 show that there is cointegration when economic growth, electricity access, and remittances are dependent variables, respectively. Economic growth and remittances functions were significant at 5% as their respective *F*-statistic (4.48, 4.98) values exceeded the Pesaran *et al.* (2001) upper critical values. Electricity access function was significant at 1%. Therefore, the null hypotheses which states that there is no cointegration for these three functions was rejected. No decision was made on cointegration status on capital and trade functions with the *F*-statistic of 2.73 and 2.85 since this values lie between the upper and lower critical values at 10% level of significance. The diagnostic tests done for the three models that confirm long-run relations show that the error term obeys all the OLS assumptions.

Table 3.   Results for ARDL Bounds Test for Cointegration.

Model	*F*-Statistics	Diagnostic Tests	Decision
Labor = f(GDP, capital, trade, remittances, electricity access)	1.07	Normality (0.67) Heteroscedasticity (0.0183) Serial Corr. (0.035)	No cointegration
GDP = f(Remittances, Electricity access, capital, labor, trade)	4.48	Normality (0.24) Heteroscedasticity (0.85) Serial Corr. (0.45)	Cointegration exists
Remittances = f(GDP, Electricity access, trade, capital, labor)	4.98	Normality (0.63) Heteroscedasticity (0.33) Serial Corr (0.25)	Cointegration exists
Electricity access = f(GDP, remittances, capital, labor, trade)	5.4	Normality (0.28) Heteroscedasticity (0.82) Serial Corr (0.48)	Cointegration exists
Capital = f(Electricity access. labor, GDP, remittances, trade)	2.73	Normality (0.02) Heteroscedasticity (0.99) Serial Corr (0.38)	No decision
Trade = f(GDP remittances, Electricity access, capital, labor)	2.85	Normality (0.41) Heteroscedasticity (0.05) Serial Corr (0.78)	No decision
Critical Values			
Level	10%	5%	1%
I(1)	3.52	4.01	5.06
I(0)	2.45	2.86	3.74

p-values in brackets.

Further, the Johansen and Juselius (1990) cointegration test was done, which confirmed the results. The Johansen cointegration test results are presented in Table 4.

Both the Trace statistics and maximum Eigen value tests suggest existence of one cointegrating equation at 5%. Following the establishment of cointegration, the long-run model was estimated; the results are presented in Table 5.

4.4. LONG-RUN COEFFICIENTS

The results indicate that if electricity access increases by 1%, economic growth will increase by about 0.34%. This result is significant at 5% level. This finding supports Payne (2010) energy-led growth hypothesis which argues that higher levels of energy consumption leads to higher economic growth. If remittances to Kenya grow by 1%, this leads to economic growth by 0.28%. This result was found significant at 1% level of significance. The diagnostics tests show that the model estimated is sound.

With the given results, the following error correction models were estimated, and the results are reported in Table 6. These models were estimated to investigate the short-run behavior of the variables.

Table 4.   Johansen and Juselius Cointegration Test Results.

Table 4(a). Trace Statistic.

Hypothesized No. of CE(s)	Eigen Value	Trace Statistic	0.05 Critical Value	Prob**
None*	0.859819	146.1033	117.7082	0.0003
At most 1	0.687633	87.15875	88.80380	0.0653
At most 2	0.561765	52.25148	63.87610	0.3194
At most 3	0.407043	27.50149	42.91525	0.6518
At most 4	0.206888	11.82247	25.87211	0.8241

Trace test indicates one cointegrating equation(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, **Mackinnon–Haug–Michelis (1999) *p*-values.

Table 4(b).   Maximum Eigen value Statistic.

Hypothesized No. of CE(s)	Eigen Value	Max Eigen Statistic	0.05 Critical Value	Prob**
None*	0.859819	58.94459	44.49720	0.0008
At most 1	0.687633	34.90727	38.33101	0.1175
At most 2	0.561765	24.75000	32.11832	0.3012
At most 3	0.407043	15.67901	25.82321	0.5734
At most 4	0.206888	6.953739	19.38704	0.9039

Max Eigen value test indicates one cointegrating equation(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level, ** Mackinnon–Haug–Michelis (1999) *p*-values.

Table 5.   Results of the Long-term Coefficients, Dependent Variable: Economic Growth.

| Variable	Coefficient	*t*-Statistics	P	Diagnostics	
C	22.03	1.8	(0.08)	R^2	0.93
Electricity access	0.34	2.1**	(0.04)	Normality Test	(0.57)
Capital	0.76	1.53	(0.14)	Serial Corr. LM test	(0.12)
Remittances	0.0.28	5.8***	(0.00)	Breusch–Pagan–Godfrey test	(0.57)
Labor	−3.4	−1.39	(0.17)		
trade	−0.39	−0.97	(0.33)		

p-values in brackets. ***, **, denote significance at 1% and 5%, respectively.

Table 6.   Error Correction Estimated Coefficients Dependent Variable D(GDP).

Variable	Coefficient	t-Statistics	Normality (0.24)
C	0.08	2.6	
D(GDP(−1))	0.23	1.03	
D(capital)	−0.29	−1.59	
D(labor)	0.55	0.27	Serial correlation (0.220 Heteroscedasticity (0.230) $R^2 = 0.36$
D(Trade)	−0.11	−0.72	
D(Electricity access)	0.013	0.36	
D(Electricity access(−1))	−0.028	−0.69	
D(Remittances)	0.014	0.80	
ECT(−1)	−0.14**	−2.0	

** Significant at 5%.

Figure 1. Plot of CUSUM of Squares Test.
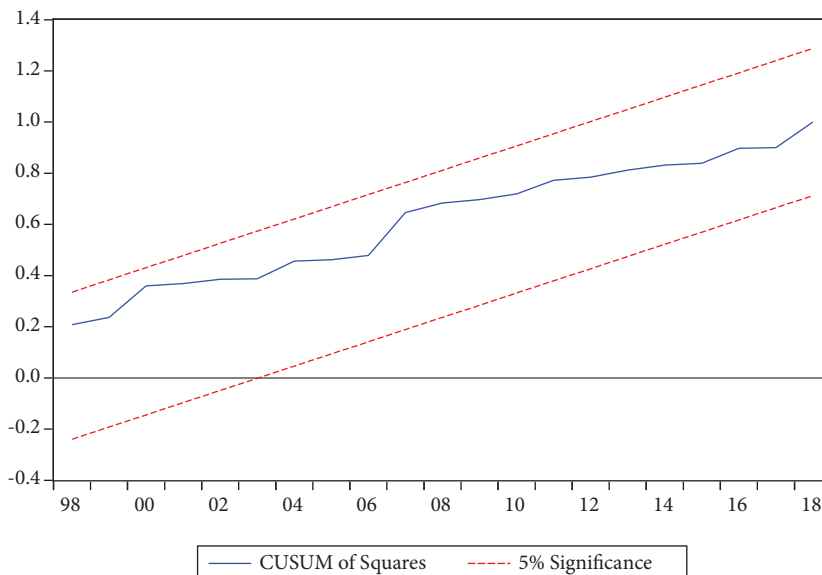
Source: study data

4.5.   Results of Error Correction Models

Table 6 presents the results of estimation of the error correction model. The coefficient of the error correction term is negative (−0.14) and statistically significant at 5%. This suggests that about 14% of the disequilibrium of economic growth from its long-run value in the short run is corrected each year. This coefficient also confirms existence of cointegration between the variables.

4.6.   Causality Analysis

Causality relationship between variables was done by use of the Granger causality test. The test aims at finding out if one time series can be used in forecasting the other. The Granger causality test results are presented in Table 7.

Table 7.   Granger Causality Test Results.

Null Hypothesis	Lag 1			Lag 2			Lag 3		
	Obs	*F*-stat	Prob	Obs	*F*-stat	Prob	Obs	*F*-stat	Prob
Electricity access does not cause GDP	31	1.15	0.29	30	0.97	0.38	29	6.4	0.002
GDP does not cause Electricity access	31	11.5	0.002	30	5.6	0.009	29	3.0	0.05
Remittances does not cause GDP	31	0.42	0.52	30	0.87	0.42	29	0.68	0.56
GDP does not cause Remittances	31	8.38	0.007	30	7.43	0.003	29	5.27	0.006
Remittances does not cause Electricity access	31	2.57	0.11	30	0.92	0.40	29	4.01	0.02
Electricity access does not cause remittances	31	1.65	0.2	30	0.76	0.47	29	0.59	0.62

Table 7 shows the pairwise Granger causality between the variables of interest in this paper in lags:1, lags:2, and lags:3. The numbers of years the past behavior of the variables significantly affected the current are indicated by the lags.

The results in Table 7 for lag 1 show that there is unidirectional causality between GDP and electricity access in Kenya. The *F*-statistic value of 11.5 is statistically significant at 1% level. Hence, the null hypothesis that GDP is not the Granger causality for electricity access is rejected. However, the null hypothesis that electricity access is not the Granger causality for GDP is accepted with the low value of *F*-statistic of 1.15 and probability of 0.29. Therefore, the Granger causality test confirms a unidirectional causality from GDP to electricity access. This results agrees with Bruns *et al*. (2014) finding that there is causal effect running from output to energy use.

The results in Table 7 show that there is unidirectional causality between GDP and remittances in Kenya for the period under study. The results for lag 1 show that the null hypothesis that GDP Granger causes remittances is rejected. The *F*-statistic value of 8.38 is statistically significant at 1% level. From the results, the null hypothesis that remittances Granger causes GDP is accepted with an *F*-statistic value of 0.42 and probability of 0.52. The Granger causality test therefore confirms that there is unidirectional Granger causality running from GDP to remittances in Kenya.

Results available in Table 7 show that there is no Granger causality between remittances and electricity access in Kenya. Results for lag 1 confirms that the null hypotheses that remittances does not Granger cause electricity access and electricity access does not Granger cause remittances are accepted. The *F*-statistic values of 2.57 and 1.65, with probabilities 0.11 and 0.2, are both statistically insignificant.

Granger causality results confirm that economic growth has positive impact on electricity access and attracts more foreign remittances.

5.   CONCLUSION

This paper investigated the long-run relationship between the variables: economic growth, remittances, and electricity access in Kenya. The paper used time series data covering the period 1987-2018. The ARDL

bounds test method was used to investigate the long-run relationship. The paper found that there is existence of cointegration when GDP, remittances, and electricity access are dependent variables. Long-run estimated coefficients suggest that electricity access and remittances are significant determinants of economic growth in Kenya. This suggests that the government together with the private companies concerned with electricity generation, distribution, and connectivity should put more effort to see that many Kenyans are connected to the grid. The government should also put in place a conducive environment that can encourage more inflows of foreign remittances to the country since they contribute positively to economic growth in Kenya.

Granger causality tests indicate that GDP Granger causes both electricity access and remittances. The government should continue implementing policies that will enhance economic growth as this will increase electricity access and also attract more foreign remittances holding other factors constant.

Conflict of Interest
None.

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