DOES RENEWABLE ENERGY SPUR ECONOMIC GROWTH IN KENYA? AN EMPIRICAL INVESTIGATION

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ABSTRACT

In this paper, the dynamic impact of renewable energy consumption on economic growth in Kenya has been empirically examined during the period from 1990 to 2019, using the autoregressive distributed lag-bounds testing approach. The study was motivated by the call to increase renewable energy use in Kenya. Contrary to expectations, the results of the study show that renewable energy consumption has no significant impact on economic growth in Kenya, regardless of whether the analysis is in the long or short run. The study, thus, concludes that the development of the real sector in Kenya is not dependent on the exploration of renewable energy. This implies that Kenya can still pursue the necessary energy conservations policies without compromising its long-term growth trajectory.

1. INTRODUCTION

The relationship between renewable energy consumption and economic growth is beginning to generate a considerable amount of debate among academics and policy-makers. The source of the debate has been centred on the recent emphasis on and increase in renewable energy use, on the one hand, and the need to stimulate economic growth, on the other hand; yet the renewable energy use and economic growth nexus remains under-investigated. More studies on the nexus in question have been on the causal relationship between renewable energy consumption and economic growth (see, among others, Apergis & Payne, 2010; Armeanu, Vintila & Gherghina, 2017; Marques & Fuinhas, 2012; Ozcan & Ozturk; 2019), leaving only a handful studies on the impact of the former on the latter (see: Majeed, Anwar & Luni, 2021; Smolovic, Muhadinovic, Radonjic & Duraskovic, 2020).

Even where efforts have been made to explore the nexus, the outcomes remain varied at best and far from being conclusive. In the renewable energy-growth nexus literature, three strands have emerged. The first strand posits that renewable energy consumption has a positive effect on economic growth (see, among others, Cetin, 2016; Kamoun, Abdelkafi & Ghorbel, 2019; Majeed et al., 2021), while the second strand maintains that the impact is negative (see Tsaurai & Ngcobo, 2020; Venkatraja, 2020, among others). The third strand emphasises that renewable energy use has no significant impact on economic growth (see Nyoni & Phiri, 2018; Smolovic et al., 2020, in traditional member states). This inconclusivity motivated this study.

In Kenya, huge investments have gone into the renewable energy sector development, making the country referenced as having one of the highly developed power sectors in both the sub-Saharan Africa (SSA) and Africa, in general, with a strong national power utility and abundant renewable energy resources (United States Agency for International Development [USAID] 2022). Further, the World Bank (2022a) highlights that cooperation within the World Bank Group and partnership with other development partners acted as a launch pad for Kenya to achieve substantial headway in increasing the supply of both reliable and cheaper electricity.

Despite this remarkable stride in its energy sector, Kenya is reported to have continued to encounter substantial challenges to viable and broad economic growth (USAID, 2022). These challenges have been exacerbated by COVID-19-related economic disruptions, in addition to long-standing challenges such as corruption and economic inequality (USAID, 2022). According to the USAID (2022), two-thirds of Kenyans live in poverty. They make less than US$3.20 per day (USAID, 2022). This bright renewable energy narrative and the not-so-bright economic growth narrative in one economy have left researchers inquisitive; hence, this study aimed to explore the renewable energy and economic growth nexus in Kenya. To our knowledge, no empirical research has fully explored this nexus using data from Kenya. The closest paper to our study is based on a study by Qudrat-Ullah and Nevo (2021) on Africa, which includes a panel of 37 African countries. However, as in other panel data studies, the outcomes from such a study may not adequately provide guidance to policy makers in Kenya as they lack country-specific effects for Kenya.

Against this background, the objective of the current study is to empirically investigate the dynamic impact of renewable energy consumption on economic growth in Kenya, using the autoregressive distributed lag (ARDL) bounds testing approach. The study seeks to unravel the mystery behind the two opposing narratives currently exhibited by the Kenyan renewable and real sectors. The outcome of the study has key policy implications for Kenya.

The rest of this paper is structured as follows: Section 2 provides an overview of the energy sector and economic growth in Kenya. Section 3 reviews the literature on the impact of renewable energy consumption on economic growth, while Section 4 presents the methodology, the study's results, and the analysis thereof. Finally, section 5 concludes the study.

2. AN OVERVIEW OF RENEWABLE ENERGY AND ECONOMIC GROWTH TRENDS IN KENYA

According to USAID (2022), Kenya is among the countries with the most developed power sectors in sub-Saharan African region. Its energy arsenal includes an active private sector, a strong national power utility, and abundant renewable energy resources, such as geothermal, wind, and solar. Over the past 20 years, access to electricity has increased dramatically in Kenya, reaching an electrification rate of 89% in 2017 (COBENEFITS, 2022), with electricity access success primarily driven by its renewable energy development and innovative and strategic policies. According to the World Bank (2022a) and COBENEFITS (2022), the country's abundance of stable renewable energy resources led to an ambitious plan to achieve energy access for all by 2022. In 2019, more than 80% of the renewable energy in Kenya came from hydro and geothermal sources (Takase, Kipkoech & Essandoh, 2021).

Due to the government's investment in geothermal energy, from 2014, the power cost has been reduced by over 30%, for all consumers, irrespective of whether they are industrial or domestic consumers – thereby reducing the cost of doing business (World Bank, 2022a). The World Bank (2022a) further points out that the World Bank Group is the largest development financier of geothermal power in Kenya and has been engaged in geothermal development since the 1970s – which explains Kenya's advanced renewable energy sector as it commenced with the renewable energy journey much earlier – raising prospects for growth and shared prosperity.

Figure 1 displays the renewable energy consumption trends and the economic growth trends in Kenya over the period 1990 - 2019.

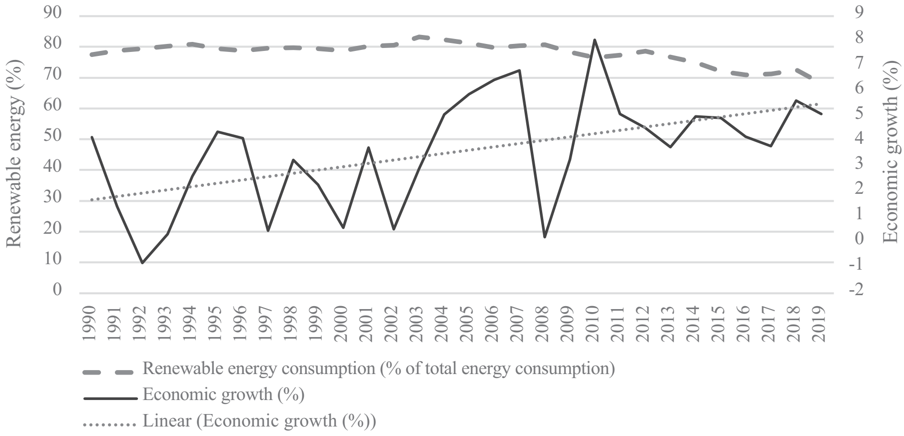


Figure 1. Trends in renewable energy consumption and economic growth in Kenya (1990-2019)

Source: Author computations; Data (World Bank, 2022b)

As displayed in Figure 1, renewable energy consumption has been gradually declining since the early 2000s, following a decade of stagnation. While the peak of 83.3% was reached in 2003, the trough of 68.1% was hit in 2019 (World Bank, 2022b). In Kenya, renewable energy consumption is high, averaging 78% of the total final energy consumption in the country per annum. On the other hand, economic growth has been stronger than most sub-Saharan African economies, averaging 3.6% per annum over the review period (World Bank, 2022b). The strongest growth of 8.1% was recorded in 2010. In the review period, Kenya once recorded a negative growth rate (of -0.8%) in 1992 (World Bank, 2022b). Over the review period, economic growth in Kenya trended upward. Pre-COVID-19 pandemic, Kenya was among the fastest-growing economies in Africa, on average, posting an annual growth rate of 5.9% between 2010 and 2018 (USAID, 2022).

Despite positive developments, Kenya, like many countries in SSA, still needs to overcome the challenges of lack of social and economic opportunities and universal access to clean, reliable, and affordable energy services to power both a resilient and sustainable economy and to provide affordable and secure energy services for domestic, productive, and value creation activities (COBENEFITS, 2022). Wood-based fuel supply is still a primary energy source in remote areas, low-income urban dwellers, and informal markets – pausing vegetation destruction and environmental degradation (Takase et al., 2021).

3. LITERATURE REVIEW

Although some work has been done in an effort to uncover the nature of the association between renewable energy consumption and economic growth, to date studies investigating the impact of renewable energy consumption on economic growth are scant as more attention has been given to the causality between the two. Even where such impact studies have been carried out, the empirical outcomes have been fundamentally indecisive – organized into three groups. The first group includes studies that found renewable energy consumption to have a positive impact on economic growth, while the second group covers the studies that found the impact to be negative. Then, there is the third category with studies that found renewable energy consumption to have a neutral impact on economic growth.

From the first group, Cetin (2016) investigated the relationship between renewable energy consumption and economic growth in the long run for E-7 countries from 1992 to 2012 based on heterogeneous panel data analysis. The results of the study revealed that renewable energy intake has a positive impact on economic growth in the study countries. Inglesi-Lotz (2016) estimated the impact of renewable energy consumption on economic welfare using panel data methods. The results showed that the impact of renewable energy use or its share of the overall energy mix on economic growth is affirmative. Charfeddine and Kahia (2019) investigated the effect of renewable energy use and financial development on carbon dioxide (CO2) emissions and economic growth in 24 countries of the Middle East and North Africa region during the period 1980 – 2015. Using panel vector autoregressive model, it was established that the impact of renewable energy on economic growth, though weak, is positive.

Haseeb, Abidin, Hye and Hartani (2019) empirically investigated the role played by renewable energy in inducing economic growth in Malaysia using annual data over the period 1980 - 2016. Based on modern econometric techniques, the study results showed that renewable energy has a significant and positive impact on economic growth in Malaysia, both in the short and long run. Mahjabeen, Shah, Chughtai and Simonetti (2020) analysed the energy-institutional stability-economic growth nexus based on a Cobb Douglas production function in D-8 countries using data from 1990 to 2016. Using the Autoregressive Distributive Lag, Fully Modified Ordinary Least Square, and Dynamic Ordinary Least Square models and tests, the results of the study showed that renewable energy consumption has a positive impact on economic growth.

Majeed et al. (2021) examined the influence of renewable and non-renewable energy consumption on economic growth for 174 economies in a global pane setting using data from 1980 to 2019. The sample was further divided into the subsamples of developed and developing countries over the review period. The renewable energy sources were also further disaggregated by production source, and an estimation of their separate impacts on economic growth ensued. Using panel estimation methods, the results revealed that renewable energy consumption has a positive impact on economic growth in all three samples – the main global sample and the developed and developing country subsamples.

Other studies that belong to the first group of studies include Rafindadi and Ozturk (2017) in the case of Germany; Zrelli (2017) for the Mediterranean countries; Khobai and Le Roux (2017) in the case of South Africa; Marinaş, Dinu, Socol and Socol (2018) in the selected Central and East European economies using the error correction model; Kamoun, Abdelkafi & Ghorbel (2019) in the case of a panel of 13 OECD countries; and Smolovic et al. (2020), in the long run in both the traditional and new European Union (EU) member states, from 2004 to 2018, in a dynamic panel ARDL setting.

In the second category of studies, Ocal and Aslan (2013) examined the renewable energy consumption-economic growth nexus in Turkey. Based on the ARDL approach, the results of the empirical tests show that renewable energy consumption has a negative impact on economic growth. Bozkurt and Destek (2015) explored the association between economic growth and renewable energy intake for the period 1980 – 2012 in selected OECD countries. The results based on the ARDL approach showed that while the impact of renewable energy use on GDP is positive in both the U.S. and Germany, it was found to be negatively correlated with GDP in Italy and Turkey, leading to the conclusion that renewable energy consumption has positive implications for economic growth but only in more developed countries.

Smolovic et al. (2020) examined the relationship between renewable energy consumption and economic growth in EU member states – both traditional and new – over the period from 2004 to 2018 using a Pooled Mean Group estimator within a dynamic panel ARDL framework. The results show that in the short term, the impact of renewable energy consumption on economic activity is negative in new member states. Tsaurai and Ngcobo (2020) investigated the impact of renewable energy consumption on economic growth in Brazil, Russia, India, China, and South Africa (BRICS) using panel data analysis and data from 1994 to 2015. Like Silva et al. (2012) and Lee and Jung (2018), all three estimation techniques yielded results showing that renewable energy use and economic growth in the study countries are negatively related.

In the same year, Venkatraja (2020) studied the impact of renewable energy on economic growth in the BRIC (Brazil, Russia, India, and China) countries, from 1990 to 2015 based on a panel regression model. The study confirmed the negative association between the two.

Then, from the third category, characterised by the neutrality of renewable energy consumption on economic growth, Dogan (2016) analysed the relationship between economic growth, renewable and non-renewable energy consumption for Turkey and found that while non-renewable energy consumption has a significant positive consequence on economic growth, renewable energy consumption has an insignificant impact on economic growth. Nyoni and Phiri (2018) empirically investigated the impact of renewable energy on economic growth utilising linear and nonlinear ARDL models and data from 1991 to 2016. Neutral results were confirmed in South Africa.

Smolovic et al. (2020) examined the link between renewable energy utilisation and economic growth in the EU member states from 2004 to 2018 and found the renewable energy use to be insignificant in determining economic activity, but only in the traditional member states.

On balance, the reviewed literature has shown that although most studies on the impact of renewable energy consumption on economic growth fall in the first category, an assumption that renewable energy has a positive impact on economic growth should be taken with a large pinch of salt, as there is also evidence to the contrary – thereby strengthening the need for country-specific studies on the topic in order to promote evidence-based policy formulation and implementation.

4. METHODOLOGY

4.1 The ARDL Bounds Testing Approach

This study utilises the autoregressive distributed lag (ARDL)-bounds testing approach to examine the cointegration relationship among variables and the impact of renewable energy consumption on economic growth in Kenya. This approach was deemed suitable as it has copious advantages. The ARDL test has superior small sample properties (Pesaran & Shin, 1999). It provides estimates of the long-run model that are not biased and valid t-statistics even though some of the regressors could be determined in the model (Nyasha & Odhiambo, 2016, 2020; Nyasha, Odhiambo & Musakwa, 2022; Odhiambo, 2008; Pesaran, Shin & Smith, 2001) and it is non-restrictive on the order of integration of variables in the model, as long as the order is less than two. The approach is also simple, using single equations rather than a set of multiple equations, yet with reliable outcomes. In addition, it automatically incorporates dynamism in its estimation. Its superiority over the conventional methods has been attested to by its increased use in empirical research in recent times.

4.2 Specification of the Empirical Model

Four additional variables are added to the model to ensure the model is fully specified and that the omission-of-variable bias is addressed. These variables are trade openness, domestic investment, human capital, and inflation, and these are known in the literature to be linked with economic growth (see Nyasha & Odhiambo, 2019). While the coefficients of the first three additional variables are expected to be positive, the coefficient of the last variable is expected to be negative. The independent variable of interest, renewable energy consumption, is expected to have a positive impact on economic growth; hence, its coefficient is expected to be positive. To empirically examine the impact of renewable energy consumption on economic growth, the empirical ARDL model specified in this study is:

$$\Delta EG_t = \Omega_0 + \sum_{i=1}^{n}\Omega_{1i}\Delta EG_{t-i} + \sum_{i=0}^{n}\Omega_{2i}\Delta RE_{t-i} + \sum_{i=0}^{n}\Omega_{3i}\Delta IN_{t-i} + \sum_{i=0}^{n}\Omega_{4i}\Delta PG_{t-i}$$
$$+ \sum_{i=0}^{n}\Omega_{5i}\Delta DI_{t-i} + \sum_{i=0}^{n}\Omega_{6i}\Delta TO_{t-i} + \Omega_7 EG_{t-1} + \Omega_8 RE_{t-1} + \Omega_9 IN_{t-1}$$
$$+ \Omega_{10} PG_{t-1} + \Omega_{11} DI_{t-1} + \Omega_{12} TO_{t-1} + \mu_t \qquad (1)$$

Where:

EG is economic growth, measured by the growth rate of GDP; RE is renewable energy consumption, proxied by renewable energy consumed as a share of total energy consumed; IN is inflation, measured by consumer prices (annual %); PG is human capital, proxied by population growth rate (annual %); DI is domestic investment, proxied by gross fixed capital formation as a percentage of GDP; and TO is trade openness, calculated as the sum of imports and exports as a percentage of GDP.

Ω_0 is a constant, Ω1-6 and Ω7-12 are short-run and long-run coefficients, Δ is the difference operator, n is the lag length and μt is the white noise-error term.

Following equation (1), the ARDL-based error-correction model is specified as:

$$\Delta EG_t = \Omega_0 + \sum_{i=1}^{n}\Omega_{1i}\Delta EG_{t-i} + \sum_{i=0}^{n}\Omega_{2i}\Delta RE_{t-i} + \sum_{i=0}^{n}\Omega_{3i}\Delta IN_{t-i} + \sum_{i=0}^{n}\Omega_{4i}\Delta PG_{t-i} + \sum_{i=0}^{n}\Omega_{5i}\Delta DI_{t-i} + \sum_{i=0}^{n}\Omega_{6i}\Delta TO_{t-i} + \xi_1 ECM_{t-1} + \mu_t$$

Where:

ECM represents the error-correction term; and its coefficient term; μt represents the mutually uncorrelated white-noise residuals. The rest of the variables and characters are as defined in Equation 1.

4.3 Data

The annual time series data from 1990 to 2019, for this study, was sourced from the World Bank Databank (World Bank, 2022b).

5. EMPIRICAL RESULTS

5.1 Stationarity Tests

The Dickey-Fuller generalised least squares (DF-GLS) and Phillips-Perron (PP) tests were utilised to test all the variables for stationarity in an effort to determine the suitability of the ARDL-bounds testing approach chosen for empirical tests. The outcome of the stationarity tests on all variables are summarised in Table 1.

Table 1. Results of Stationarity Tests – All Variables in Estimated Model

	Dickey-Fuller generalised least square **(DF_GLS)**				Phillips – Perron **(PP)**			
	Level variables		1st differenced variables		Level variables		1st differenced variables	
Variable	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend
EG	-3.470***	-4.583***	-	-	-3.488**	-4.764***	-	-
RE	-0.232	-1.188	-3.853***	-4.852***	-0.835	0.486	-3.752***	-5.184***
IN	-1.984**	-2.396	-	-6.144***	-2.996**	-3.585**	-	-
PG	0.207	-3.073**	-1.864*	-	-1.515	-2.153	-2.680*	-3.438*
DI	-2.294**	-2.879	-	-5.465***	-2.388	-3.116	-9.034***	-8.831***
TO	-1.203	-2.628	-3.583***	-3.553***	-1.131	-2.635	-5.630***	-6.077***

Notes: *, ** and *** denotes stationarity at 10%, 5% and 1% significant levels respectively

Source: Authors' calculation

The results of the unit root tests reported in Table 1 show that while some variables were integrated of order zero, other variables were integrated of order one. Furthermore, no variable was stationarity after being differenced more than once, confirming that the ARDL-bounds testing approach is suitable for this study.

5.2 Cointegration – Bounds Test

Following the confirmation that all variables of the study are stationary in either levels or after differenced once, cointegration was carried out, where the long-run relationship between the variables in the specified model is examined based on the ARDL bounds testing procedure. The results of the cointegration test are summarised in Table 2.

Table 2. Outcome of Bounds F-test for Cointegration

Dependent Variable	Function		F-statistic		Cointegration Status	
EG	F(EG|RE, IN, PG, DI, TO)		5.03***		Cointegrated	
	Asymptotic Critical Values					
Pesaran et al. (2001), p.300, Table CI(iii) Case III	1%		5%		10%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	3.41	4.68	2.62	3.79	2.26	3.35

Note: *** denotes statistical significance at 1% level

Source: Authors' calculation

As reported in Table 2, the results of the ARDL bounds test for cointegration reveal that the calculated F-statistic of 5.03 is greater than the upper bound critical value, reported by Pesaran et al. (2001) in Table CI(iii) Case III, at 1% significance level. The results confirm the existence of a stable long-run association of the variables in the specified model, hence it is confirmed that the variables are cointegrated. This confirmation is critical as it allows for the estimation of the coefficients.

5.3 Coefficient Estimation

As part of the model estimation, optimal lag length for the model was determined by using the Schwarz Information Criterion (SIC) as it produced a more parsimonious model than the Akaike Information Criterion based model. The resultant optimal lag length selected based on SIC is ARDL(1,0,0,0,1,0). Both the long-run and the short-run coefficients of the study are displayed in Table 3, Panel A and Panel B, respectively.

Table 3. Results of Coefficient Estimation

Panel A: Long-run coefficients [Dependent variable: real GDP growth rate (**EG**)]	
Regressor	Co-efficient (t-statistic)
C	21.163 (1.332)
RE	-0.363 (-1.464)
IN	-0.087* (-1.951)
PG	0.887 (0.243)
DI	0.328* (1.864)
TO	0.085 (1.250)
Panel B: Short-run coefficients [Dependent variable: real GDP growth rate (Δ**EG**)]	
ΔRE	-0.392 (-1.416)
ΔIN	-0.094* (-2.026)
ΔPG	0.381* (1.762)
ΔDI	0.355* (1.825)
ΔTO	0.091 (1.242)
Ecm (-1)	-0.981*** (-5.753)

R-Squared	0.735	R-Bar-Squared	0.651
SE of Regression	1.686	F-Stat F(6,21)	6.212[0.001]
Residual Sum of Squares	56.841	DW statistic	2.124

Note: * and ** denote stationarity at 10% and 5% significance levels respectively.

Source: Authors' calculation

The results of the estimated model reported in Table 3 reveal that in Kenya, renewable energy consumption has no significant impact on economic growth, both in the long run and in the short run. These results are confirmed by the long-run (RE) and short-run (ΔRE) coefficients of renewable energy consumption that are statistically insignificant. Although these results are contrary to expectations, they are far from being unusual. Smolovic et al. (2020), in the case of traditional member states, and Nyoni and Phiri (2018) also found the relationship between renewable energy consumption and economic growth to be neutral. Though unpopular, these results could have been driven by inefficiencies – possibly reversing the gains derived from renewable energy consumption.

Further analysis of the results shown in Table 3 shows that other results of the study are varied. While the relationship between trade openness and economic growth was insignificant, domestic investment and inflation had a significant impact on economic growth in Kenya. These results applied both in the long and short run. Although the latter two variables have a significant influence on economic growth, as per expectations, domestic investment has a positive effect, while inflation has a negative impact on economic growth. The impact of human capital on economic growth turned out to be mixed – neutral in the long run but positive in the short run. In the event of a shock in Kenya, the equilibrium would be regained at a rate of 98% per annum, as reflected by the coefficient of the lagged error correcting term that is negative and statistically significant at a 1% level, with a 98% magnitude.

Diagnostic tests were performed for serial correlation, heteroscedasticity, functional form and normality. The results show that the model passed all the diagnostic tests, as shown in Table 4. Stability tests were also performed based on the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals CUSUMQ), and the results are displayed in Table 5. The results confirm that the parameter stability of this model in the sample period.

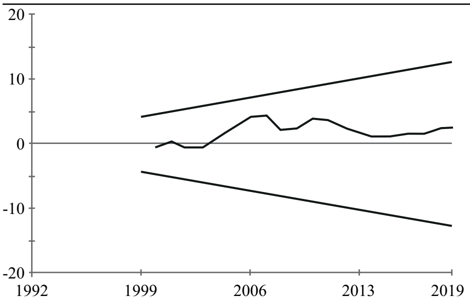
Table 4. Diagnostic Tests

LM Test Statistic	Results [Probability]
Serial Correlation: CHSQ(1	0.425[0.515]
Functional Form: CHSQ(1)	0.710 [0.399]
Normality: CHSQ (2)	1.342[0.511]
Heteroscedasticity: CHSQ (1)	0.108[0.742]

Source: Authors' calculation

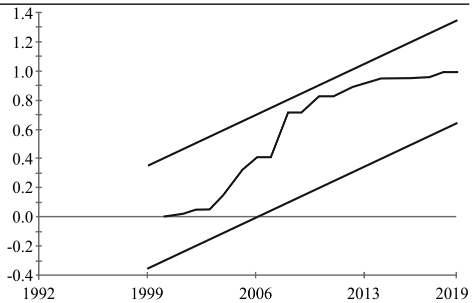
Table 5. Plot of CUSUM and CUSUMQ

Plot of CUSUM



The straight lines represent critical bounds at 5% significance level

Plot of CUSUMQ



The straight lines represent critical bounds at 5% significance level

Source: Authors' computations from microfit output

6. CONCLUSIONS

In this paper, the dynamic impact of renewable energy consumption on economic growth in Kenya has been empirically investigated over the period 1990 – 2019. Although there have been calls to increase renewable energy utilisation in Kenya as part of reducing greenhouse gas emissions, the impact of such increased use on economic growth has not been put to the test, yet it has huge energy and growth policy implications for the country. The study used the ARDL-bounds testing approach to examine this relationship. The results of the study revealed that in Kenya, renewable energy consumption has no significant impact on economic growth, regardless of the period of analysis – long or short term. Therefore, the study concludes that the development of the real sector in Kenya is not dependent on the exploration of renewable energy. From a policy perspective, these results imply that policies on energy conservation can be implemented in Kenya without threatening economic growth.

Conflict of interests

The authors declare that there is no conflict of interest.

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ДА ЛИ ОБНОВЉИВА ЕНЕРГИЈА ПОДСТИЧЕ ЕКОНОМСКИ РАСТ У КЕНИЈИ - ЕМПИРИЈСКО ИСТРАЖИВАЊЕ

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САЖЕТАК

У овом раду динамички утицај потрошње обновљиве енергије на економски раст у Кенији емпиријски је испитан током периода од 1990. до 2019. године, коришћењем приступа тестирања ауторегресивне дистрибуиране границе кашњења. Студија је мотивисана потребом да се повећа употреба обновљиве енергије у Кенији. Супротно очекивањима, резултати студије показују да потрошња обновљиве енергије нема значајнији утицај на економски раст у Кенији без обзира да ли се ради о дугорочној или краткорочној анализи. Дакле, у студији се закључује да развој реалног сектора у Кенији не зависи од употребе обновљивих извора енергије. То имплицира да Кенија и даље може да спроводи неопходне политике уштеде енергије без угрожавања своје дугорочне путање раста.

Кључне ријечи: *Кенија, потрошња обновљиве енергије, енергетски микс, економски раст.*