Journal of International Trade, Logistics and Law, Vol. 8, Num. 1, 2022, 121-132

IMPACT OF ELECTRICITY CONSUMPTION ON ETHIOPIAN ECONOMIC GROWTH: AN EMPIRICAL ANALYSIS

Gelana DAMENA
Development Center, Addis Ababa, Ethiopia

Leta SERA
Jimma University, Ethiopia

Negese Tamirat MALATU
Jimma University, Ethiopia

Received: April 14, 2022 Accepted: May 27, 2022 Published: June 01, 2022

Abstract:
Electricity consumption plays a vital role in achieving sustainable economic growth. This study attempts to investigate the impact of electricity consumption on Ethiopian economic growth, time-series data was ranging from 1980 to 2018. The Autoregressive Distributed Lag Model (ARDL) was developed for the data analysis. The results of ARDL revealed that the economic growth was significantly affected by electricity consumption, energy consumption, foreign direct investment, and electricity price both in the long run and short run. While also affected by urbanization and government consumption in the long run. The speed of adjustment revealed that 60.12% of the short-run adjustment is made per year towards long-run equilibrium. Water, mine, and energy office should give important attention to electricity wastage control and integrated monitoring strategies to electricity consumption which are crucial for improving Ethiopian economic growth. The summary of electricity consumption by policymakers and plan designers could bring better improvement on economic growth.

Keywords:
Economic Growth, Electricity Consumption, Energy Consumption, Ethiopia, Long-run Equilibrium

1. Introduction

Economic growth is a continuous rise in the real gross product over the years which are influenced by investment and urbanization. Electricity is a key factor contributing an important role to economic stability. Hence, inadequate supply of energy affects all aspects of economic and social development in less developed countries because growth and development in less developed countries have been focused on energy consumption. In Ethiopia, unlike developed countries access to modern electricity services is an enormous challenge. Particularly, the recent estimates suggest that above 60 million peoples is lack access to electricity. The production process requires a significant amount of energy which is expected to create a strong interaction between economic and energy policies to accelerate economic growth [1]. Accelerate the economic growth of the country by thoroughly investing in the electricity sector as a pertinent option to achieve sustainable economic growth [2].

Electricity plays a crucial role in the economic growth performance of the countries. Ethiopian rapid economic growth demand for electricity has been steadily increasing. The main rationale behind the current investigation carried out in Ethiopia is evidence of empirical analysis. Hence, the existing empirical studies that have been highlighted and intensely discussed detail on the contribution of energy in economic growth [3]. The detail is on the very crucial role of energy consumption in accelerating economic development and redirected energy as a vital ingredient of sustainable economic growth. This indicated that the link between energy consumption and economic growth in Ethiopia is still mixed in terms of causality and magnitude of the impact of electricity consumption on economic growth. However, in Ethiopia, there are some inconsistencies in the empirical result of energy consumption's impact on economic growth.

Time series analysis determining the order and fractional integration for the series carried out through particular unit root tests [4]. Analysis of causal effect neglected to apply vigorous FMOLS estimation techniques to overcome the existence of estimation problem [5]. May previous empirical investigation with autoregressive distributed lag model subjected to the serious methodological problem [6]. Their studies do not take into account for bias of omitted variables such as urbanization and foreign direct investment [7]. The study does not develop several potential factors behind energy consumption and economic growth technique. Most of them were incompleteness of basic growth model and suffered from a short span of data 5 years on average which lowering power of the test. For certain sample sizes, the power is based on the period of the data and the power is greater when the span is large [8].

Despite the great role of electricity consumption on economic growth has been ignored to some extent by most literature in Ethiopia. Still, a questionable issue that needs focus in Ethiopia is how large the magnitude of the impact of electricity consumption is on economic growth. In lightening of this, the paper aims to test the impact of electricity consumption on the Ethiopian economy and pinpointed co-integration between employed variables. Therefore, the general objective of this study is to empirically investigate the impact of electricity consumption on Ethiopian economic growth by employing time series data set for the periods ranging from 1980 to 2018.

Understanding the factors underlying electricity consumption is crucial in terms of achieving sustainable economic growth, alleviating poverty and food insecurity. There is a growing body of literature focusing on electricity consumption and its impact on economic growth [9 – 14]. As the studies conducted by [15 – 25], empirical outcomes evident electricity consumption has positive impacts on economic growth using a different variables like electricity consumption, cost of fuel or gas, foreign direct investment, urbanization, non–renewable energy, renewable and viable energy consumption, and oil energy. Their findings advise that it is better to keep employment of new policies to progress of electricity consumption to attract more foreign investment and achieve rapid and sustainable economic growth. Building on existing studies, we extend the analysis by considering a comprehensive set of gross domestic product growth. To this end, the current study was developed to investigate the effects of electricity consumption on Ethiopia's economic growth.

2. Materials and Methods

2.1. Types and Sources of Data

Time series data was developed for the study ranging from 1980/81 to 2018/19 time period. Analysis of the study was depending on the availability and quality of secondary data. Data like real growth domestic product, government consumption, and rate of inflation were collected from the national bank of Ethiopia and the ministry of finance and economic cooperation. Data on electricity consumption, energy consumption, electricity production, electricity customers, and electricity price were collected from Ethiopian electricity sectors and the ministry of water resource, irrigation, and energy. Foreign direct and domestic investment data was collected from the Ethiopian investment commission and urbanization data from the Ethiopian central statistical agency. The remaining data were collected from the international monetary fund, world development indicator, World Bank group report, United Nations conference for trade and development, international energy agency, and global economy websites.

2.2. Model Specification

To achieve the objective of the study basic growth econometric model was developed. To examine the long-run and short-run relationship between electricity consumption and sustainable economic growth the multivariate framework was employed. Among these multivariate frameworks, the Cobb-Douglas production function with constant returns to scale was the preferable one for this study. Cobb-Douglas production function can be expressed:

$$Y = AK^{\alpha}L^{\beta} \quad (1)$$

Where Y is a real GDP, A is a factor of productivity technology, K is real capital and L is labor.

The above-mentioned Cobb-Douglas production function (equation1) by including different determinant factors of electricity consumption such as technology, urbanization, foreign direct investment, domestic investment, aggregate energy consumption per capita, electricity production, government consumption, electricity customer, electricity price, rate of inflation and its impact on economic growth can be expressed:

$$RGDP = A\,ELCON^{\beta 1} URBAE^{\beta 2} FDIAE^{\beta 3} DIAE^{\beta 4} ENCO^{\beta 5} ELPRO^{\beta 6} GCON^{\beta 7} ELCUS^{\beta 8} ELPR^{\beta 9} INFR^{\beta 10} e \quad .... (2)$$

Where RGDP is a real gross domestic product, A is technology, ELCON is electricity consumption, URBAE is urbanization, FDIAE is foreign direct investment, DIAE is domestic investment, ENCO is aggregate energy consumption per capita, ELPRO is electricity production, GCON is government consumption, ELCUS is electricity customer, ELPR is electricity price, INFR is inflation and *e* is an error term assumed to normally and independently distributed as e ~Ni $(0, \delta^2)$ with zero mean and constant variance $\delta.^2$ Finally, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_{47}, \beta_8, \beta_9, \beta_{10}$ are returned to scale parameters of the econometrics model.
To linearize the parameters Cobb-Douglas production function is transformed into log-linear form. The natural logarithm is important to study the association between real gross product and energy consumption to obtain efficient and consistent estimates. Cobb-Douglas production function in log-linear form is presented:

$$LNRGDP_t = LNA + \beta_1 LNELCON_t + \beta_2 LNURBAE_t + \beta_3 LNFDIAE_t + \beta_4 LNDIAE_t + \beta_5 LNENCO_t + \beta_6 LNELPRO_t + \beta_7 LNGCON_t + \beta_8 LNELCUS_t + \beta_9 LNELPR_t + \beta_{10} LNINFR_t + e_t \quad .... (3)$$

The above log linear function (equation 3) modified by including two indicator such as PtDumm and DtDumm can be expressed:

$$LNRGDP_t = \beta_o + \beta_1 LN\,(ELCON_t) + \beta_2 (URBAE_t) + \beta_3 (GRFDIAE_t) + \beta_4 (DIAE_t) + \beta_5 (LNENCO_t) + \beta_6 (LNELPRO_t) + \beta_7 (LNGCON_t) + \beta_8 (LNELCUS_t) + \beta_9 (LNELPR_t) + \beta_{10} (INFR_t) + \beta_{11} (D_t Dumm) + \beta_{12} (P_t Dumm) + et \quad ....(4)$$

Where $LNRGDP_t$ is the Natural logarithm of real GDP, $LNELCON_t$ is the Natural logarithm of electricity consumption, $LNURBAE_t$ is Natural logarithm urbanization, $GRFDIAE_t$ is the Growth rate of foreign direct investment, $LNDIAE_t$ is Natural logarithm domestic investment, $LNENCO_t$ is the Natural logarithm of energy consumption per capita, $LNELPRO_t$ is Natural logarithm of electricity generation, $LNGCON_t$ is Natural logarithm of government consumption, $LNELCUS_t$ is Natural logarithm of electricity customer, $LNELPR_t$ is Natural logarithm of electricity price, $LNINFR_t$ is Natural logarithm of inflation, P_tDumm is Drought time indicator, D_tDumm is a Policy time indicator, $\beta_o - \beta_{12}$ is the coefficients as model parameters and e_t is an error term.
Drought time indicator (DtDumm) was negatively correlated with the economy, especially in developing countries. In Ethiopia, drought affects economic growth, aggregate water resources, and electricity production. It contributes to diminishing electricity production capacity which is tangible in the current electricity utilization of the country. Policy time indicator (PtDumm) was positively correlated with the economy. It is important to estimate short and long-run relationships between macro variables including time dummy of drastic policy change events.

2.3. Method of Data Analysis
Time series data was developed for the study ranging from 1980/81 to 2018/19 time period. An econometric model such as the autoregressive distributive lags model was developed for the data analysis. Autoregressive Distributed Lag (ARDL) model is a dynamic distributed-lag model in which the effect of a regressor x on y occurs over some time rather than all at once and the model is developed for the means and variances are constant and not depending on time. The selected ARDL (k) model long-run equation can be expressed:

$$Y_t = \sum_{i=1}^{k} \alpha_1 x_{1t} + \sum_{i=1}^{k} \alpha_2 X_{2t} + \sum_{i=1}^{k} \alpha_3 X_{3t} + \sum_{i=1}^{k} \alpha_4 X_{4t} + ... \sum_{i=1}^{k} \alpha_n X_{nt} + v_{1t}; \ s\ (X_{1t}, X_{2t}, X_{3t} ... X_{nt})$$

These are the explanatory variables is the number of optimum lag order.

Unit root tests for sensitivity analysis, post model estimation diagnostic tests to check the stability of the parameters in the model, and structural tests for a known structural break and unknown point of the structural break were developed. Data analysis was done with the latest version of gretl-2019c, R-studio of version 2019, and Eviews-11.

3. Results and Discussion

3.1 Descriptive analysis

3.1.1. Modalities of Electricity Production and Consumption in Ethiopia

Figure 1 describes and represented the time series interaction for Growth rate Electricity Consumption and electricity production over the study periods. Hence there is a related trend seen between the two factors except at the starting years of the investigation there was 35.30% in the amount of consumed since 1980/81 with unmatched with power generated which recorded as 10.23% with the same year. The maximum rate of electricity production since 2012/13 was shown as maximum growth rate in generation capacity and with the same clarification, the power consumed was counted as 33.03% growth rate almost relatively with power produced which shown an increasing trend. From 2016/17 up to 2018/19, the amount of electricity consumption displayed a constant trend while the amount of production was raised from 9.93% to 19.84% Growth rate the back declined to 9.95% to the end of the study periods with relatively declining trends as seen on the time series plot. Country following the successful launch and rolling implementation of Ethiopia's First National Electrification Program in 2017, the Government of Ethiopia has achieved significant milestones in connecting 33% of its population with on-grid electrification and 11% with off-grid pre-electrification, with the combined achievement of 44% of electricity access. Although substantial progress has been made in the sector, Ethiopia's electrification needs are still significant. More than half of Ethiopia's populations 56%-60% still do not have access to electricity. According to Minister Water resource and energy by 2025, Ethiopia desires to attain middle-income country status, rural and urban electricity access is targeted to achieve 100%. Achieving Ethiopia's development vision of transformative growth and widely shared prosperity requires the timely provision of adequate, affordable, and reliable electricity access to all. Clean electricity access is an essential pillar of sustainable development, economic growth, and environmental development.

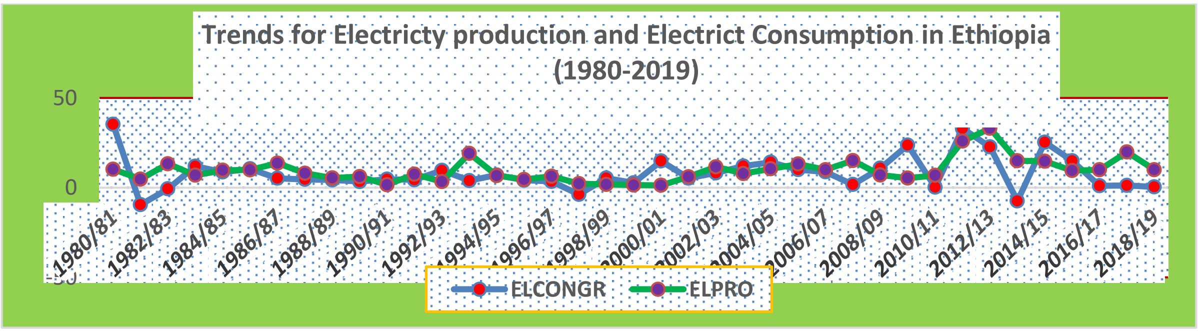
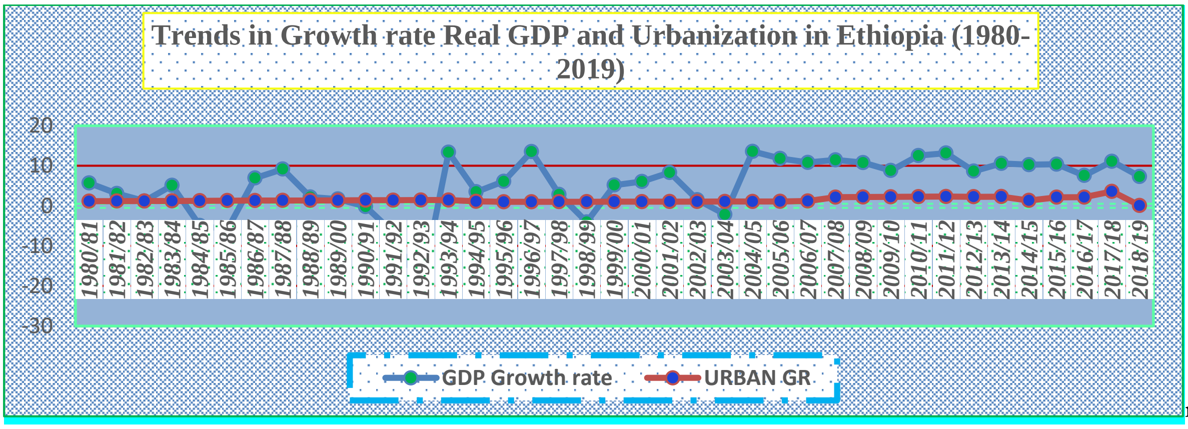


Figure 1: Trends of Electricity Production and Electricity Consumption in Ethiopia
Source: Ethiopian Electricity power production and Power utility 2020

3.1.2. Urbanization and Economic Growth in Ethiopia

Ethiopia has one of the fastest-growing urban populations in the world with the number of people living in cities expected to nearly triple in the next two decades. This demographic dividend presents a real opportunity to change the structure and location of economic activity from rural agriculture to more diversified and much larger urban industrial and service sectors. For urbanization to contribute fully to economic growth and transformation it will have to be managed well. Ethiopia already benefits from high rates of economic growth but among most other countries at similar levels of urbanization, it has the lowest gross national income. Moreover, growth has been driven mainly by public investment and agriculture, and rapid urbanization has not been accompanied by the structural transformation of the economy. According to United Nation Development Program (2018), Ethiopia is still predominantly a rural country with only 20% of its population living in urban areas. But this is set to change dramatically in parallel with rapid urbanization. For example, Addis Ababa is Ethiopia's only city with municipal sewerage which serves only 10% of the population. Solid waste management remains a challenge often dumped into open areas, endangering public health. Figure 2 based on the data obtained from the Ethiopian central statistical agency indicated that the highest rate of urbanization was since 2004/05 was registered as 13.57% was followed the urbanization rate registered during 1996/97 was computed to be 13.53%. The lowest growth rate of urbanization during 1992/1993 was scored to be 21.00%. To sum up, the average total urbanization registered was 14.40 over the study period 1980/81 up 2018/19. The Ethiopian context rate of urbanization is still said to be exhibited the constant trend exceptional for the previous years included in this study periods which was exhibited the declining.



nd

Figure 2: Trends Economic Growth a rate of Urbanization in Ethiopia

3.1.3. Trends of Inflation and Economic Growth in Ethiopia

According to classical theories, inflation occurs in an economy when the overall price level increases and the demand for goods and services increases. Based on the Keynesian theory's inflation occurs when demand exceeds the potential output of the economy. Currently, the word inflation is a major problem and the issue of more detention around the world. In the Ethiopian context, from figure 3 the inflation was counted since the starting of this study period was 4.48% which is assumed to be related to the real GDP growth measured by $2010 later one year more since 1981/82 the inflation rate was increased to 6.13% reverse to real GDP growth which declined to 3.08% again after one year shown a decreasing trend up 1986/87 increasing rate. In General, when compared to the rises in inflation in Ethiopia since 1991/92 and 2011/12 with the rate of 35.72% and 33.25% respectively the highest amount of inflation count during 2007/08 up to 2008/09 was 44.35% with the almost constant trend of GDP during the time which was 10.78 since 2010 USA dollar was counted for a growth rate of real GDP in Ethiopia based on data obtained from an indicated institution in the above-reflected source.

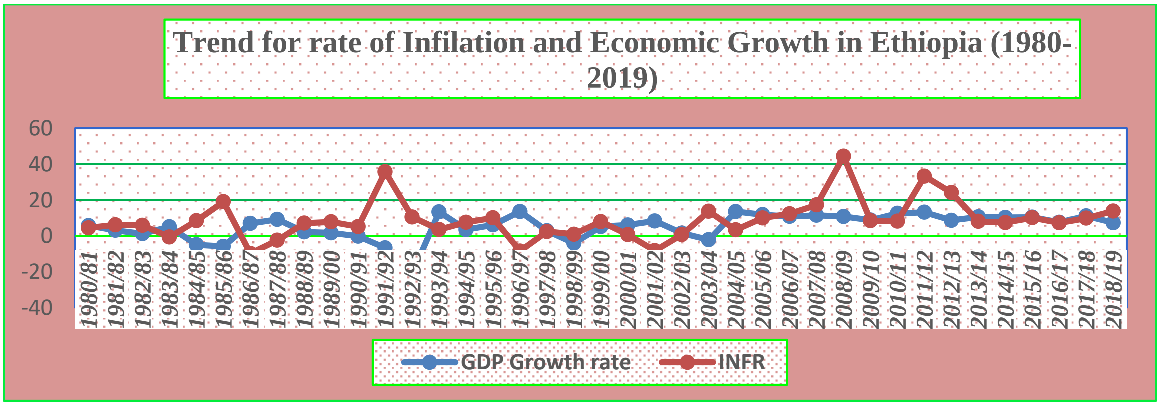


Figure 3: Trends for rate Inflation and Economic Growth in Ethiopia

Source: United Nations Conference Trade and Development 2020

Table 1 in Ethiopia the mean value of the electricity consumption period between 1980/81 - 2018/19 was 21.299 and the maximum and minimum values were 22.896 and 20.007 respectively. Similarly, the mean value of LNRGDP is 5.4124 and minimum of 6.9228, and a maximum of -21.0030. The standard deviation of electricity consumption is 0.8438. These results revealed that there is a low variety of electricity consumption from time to time in Ethiopia. The data of electricity consumption was positively skewed, which indicated that the mean of the data is greater than the median.

Table 1 Summary Statistics for Variables, Using the Observations 1980 - 2018

Variable	Mean Std.dev.	Mini. Max.	Median C.V.	Skewness Kurtosis
LNRGDP	5.4124	21.0030	6.9228	-1.4905
	7.1560	13.5740	1.3221	2.9395
LNELCON	21.299	20.007	21.042	0.51706
	0.8438	22.896	0.0396	-0.85224
URBAE	14.803	10.41	14.553	0.33394
	2.8761	20.698	0.19429	-0.86551
GRFDIAE	1.7088	-0.0372	0.78548	0.75951
	1.9498	5.673	1.1410	-0.88858
LNDIAE	21.889	10.591	20.221	0.86633
	8.7866	39.422	0.40141	-0.46329
	8.6312	8.6073	8.6205	1.4112
LN ENCO	0.02273	8.6935	0.0026	1.0435
LNELPRO	21.422	20.000	21.193	0.51847
	0.93664	23.3480	0.0437	-0.69782
LNGCON	7.881	6.8430	7.6331	0.65115
	0.78615	9.4089	0.0997	-0.88636
LNELCUS	13.4470	12.4090	13.2990	0.26461
	0.7128	14.9620	0.0530	-1.1485
LNELPR	13.9650	8.7010	14.3400	-0.28572
	2.9568	18.9470	0.2117	-0.92437
INFR	8.8662	-9.8092	7.8174	1.2648
	10.968	44.3570	1.2371	2.3577

Source: Own Computation with gretl 2020a (2020) *Total 39 Observation

3.2 Unit Root Test Analysis

Test for stationarity is crucial to address unit root problems in the data series. Unit root tests were carried out to determine the degree of fractional integrations for each series in a specified model. The tests were served as a way to account for the robustness of the result. Conditions unit root tests were developed before any sort of action was taken. Unit root test results revealed that URBAE and LNELCUS became stationary at a 5% significant level. The only variables became stationary after their first difference with a similar significant level while the rest all variables were stationary at their first difference which is said to be integrated of order one I (1) by both modified Dickey-Fuller GLS and Kwiatkowski-Phillips-Schmidt's-shin at 1% significant level.

Table 2 revealed that the fractional integration unit root test was developed to test the hypothesis for an alternative to the null hypothesis. This states that there is no long-run dependency in the series of each variable included in the estimated model. All variables except, LNGDP (0.396) and LNELCON (1.001) with an estimated degree of integration were much far from zero indicated that the presence of the long-range dependency. Moreover, the significance of all variables in the estimated degree of integration is the likeness of a high degree of dependency in the series for the Local Whittle Estimator (LWE) unit root tests. In detail for Geweke-Porter-Hudak (GPH) unit root test for all variables and estimated degree of integration are statistically significant with the presence of long-range dependency of series. This indicates that the rejection of the null hypothesis of no long-run dependency between series is said to be there is the highest degree of dependency between the series.

Table 2 Test for Unit Root (Fractional Integration)

Variable	**Local Whittle Estimator (LWE)**		**Geweke-porter-Hudak (GPH)**	
	Estimated degree of integration	The test statistic(z)	Estimated degree of integration	The test statistic(
LNRGDP	0.396	2.239**	0.250	0.638
LNELCON	1.001	5.661***	1.030	21.276**
URBAE	0.939	5.313***	0.966	32.961**
GRFDIAE	0.776	4.392***	0.031	2.493**
LNDIAE	0.946	5.353***	1.129	3.310**
LNENCO	0.914	5.171***	0.937	11.992***
LNELPRO	0.908	5.137***	0.939	14.748***
LNGCON	0.989	5.596***	1.004	11.900***
LNELCUS	0.928	5.247***	0.958	13.221***
LNELPR	0.939	5.310***	0.968	17.260***
INFR	0.541	3.059***	0.502	3.872***

Source: Own computation with gretl 2020a (2020); "***, **, *" signs indicate statistical level of significance at 1%,5% and 10% respectively

3.3. Sensitivity Analysis

Sensitivity analysis was developed by employing a selected fully modified form of augmented dicky fuller unit root test. Sensitivity analysis with unit root tests was cheeked to determine which variable is trend stationary and difference stationery by applying the decision-based level of significance. The summarized results as real LNGDP, INFR, LNGCON, LNELPRO are found to be trend stationery for 2.5, 12.5 values of c, and x*o values for both ADF and ADF-GLS tests. Whereas, ELCON, LNDIAE, LNELPR, and LNENCO were found to be trend stationery for all c and x*o values for both unit root test applied GRFDIAE, LNELCUS and became trend stationery at the value of c= 17.5, 12.5. Finally, the variable that became different stationery was URBAE and LNEPR for ADF values and became trend stationery at 12.5 c value for ADF-GLS Unit root tests.

3.4. ARDL Bound Test for Cointegration Analysis

Ho (Null Hypothesis) revealed that there is no long-run cointegration between electricity consumption and economic growth. Ha (Alt. Hypothesis) indicated that there is long-run cointegration between electricity consumption and economic growth. The results showed that the computed value of the F-statistic is much higher than the upper-bound critical value (at the 1%, 2.5%, 5%, and 10% significant levels) when the real GDP is the dependent variable. Therefore, these ensured the existence of cointegration relationships among electricity consumption and economic growth [13]. F-statistic exceeded the critical value at 1% (i.e., 6.7997 >3.61), this implied that rejection of H0 no cointegration or long-run relationship for the model tested. Thus, indicated that there existed a cointegration between electricity consumption, urbanization, foreign direct investment, and domestic investment and real GDP. Akaike's information criterion (AIC) is better model for this study with a smaller value of information criteria.

3.5. Empirical Results and Discussions

Table 3 revealed that ARDL bound testing for cointegration between electricity consumption, urbanization, foreign direct investment, and domestic investment as a result of electricity consumption, electricity production, energy consumption per capita, government consumption, electricity customer, electricity price, and inflation rate.

Table 3 revealed that electricity consumption was positively significant at the short-run (10%) and long-run (5%) significant level. It implied that with an increase in electricity consumption by 1%, the real GDP of a country will increase by 0.2839% in the long run. The finding is consistent with their studies of [12]. The coefficient of urbanization was positively significant at 1%. It revealed that an increase in urbanization by 1% will bring up about a 0.4813% increase in real GDP. Foreign direct investment was positively correlated with real GDP at a 1% significant level both in the short-run and long run. Foreign direct investment increase by 1% in the long term leads to a 7.20E-05 % increase in real GDP. This study is similar to their studies of [9].

Table 3 Long Run Coefficient Analysis

Matching Algorithm	**ARDL Cointegrating And Long Run Form Date: 04/30/2020 Time: 11:36 Dependent Variable: LNRGDP Sample: 1980 – 2018 Selected Model: ARDL (1,0,2,0,0,1,1,2,1,2,0) Included observations: 37**			
Variables	Coefficients	Std. Error	t-Statistic	Prob.
LNELCON	0.283967	0.110777	2.563403	0.0216
URBAE	0.481332	0.124422	3.868529	0.0015
GRFDIAE	0.000072	0.000020	3.559955	0.0029
LNDIAE	-0.007914	0.006532	-1.211447	0.2445
LNENCO	4.113616	1.514569	2.716030	0.0159
LNELPRO	-0.207395	0.161439	-1.284661	0.2184
LNGCON	0.328101	0.111016	2.955427	0.0098
LNELCUS	0.043416	0.184457	0.235371	0.8171
LNELPR	-0.377928	0.080200	-4.712315	0.0003
INFR	-0.001230	0.001226	-1.002934	0.3318
PtDumm	0.340125	0.127281	2.672237	0.0174
DtDumm	-0.076547	0.036966	-2.070741	0.0561
C	-32.357370	13.427639	-2.409759	0.0293

Source: Own Computation with Eviews-11(2020)

Aggregate energy consumption per capita was positively significant at 1% and 5% in the short-run and long-run respectively. An increase in aggregate energy consumption per capita by 1% will lead to an increase in real GDP by 4.1136%. The long-term coefficient of aggregate energy usage per capita has a less deviation from that of the short-run coefficient (4.50). The finding is in line with their studies of [10, 14, 26]. According to table 4, real government consumption negatively correlated with real GDP at a 1% significant level. GDP increased by 0.3281% as a 1% increase in government consumption. The short-term and long-term estimated coefficient of inflation rate displayed a negative insignificant effect on economic growth. Electricity price and electricity customer were statistically significant at 1% in the short term and long term. The finding is consistent with the study of [26] Finally, policy time indicator (PtDumm) and drought time indicator (DtDumm) were significant at 5% and 10% respectively. Drought time indicators were negatively correlated with economic growth whereas policy time indicators positively correlated. Particularly, the drought time indicator decreases the amount of aggregate electricity consumption directly. GDP decreased by 0.0765% as a 1% increase in drought.

Finally, the long run established model has be expressed:

$$LNRGDP = -32.3573 + \underset{(0.1107)}{0.2839}(LNELCON) + \underset{(0.1244)}{0.4813}(URBAE) + \underset{(0.000020)}{0.000072}(GRFDIAE) - \underset{(0.0065)}{0.0079}(LNDIAE)$$

$$\underset{(1.5145)}{4.1136}(LNENCO) - \underset{(0.1614)}{0.2073}(LNELPRO) + \underset{(0.1110)}{0.3281}(LNGCON) + \underset{(0.1844)}{0.0434}(LNELCUS) -$$

$$\underset{(0.0802)}{0.377928}(LNELPR) - \underset{(0.0012)}{0.0012}(INFR) + \underset{(0.1272)}{0.3401}(PtDumm) - \underset{(-0.076547)}{0.0765}(DtDumm)$$

Table 4 Short Run Coefficient Analysis

	ARDL Cointegrating And Long Run Form Dependent variable: RGDP Selected Model: ARDL (1, 0, 2, 0, 0, 1, 0, 2, 1, 2, 0)		Date: 05/05/2020 Time: 11:20 Sample 1980 – 2018 Included observations: 37	
		Cointegrating form		
Variables	Coefficients	Std. Error	t-Statistic	Prob.
D (LNRGDP (-1))	0.398702	0.124803	3.194647	0.0060
D (LNELCON)	0.170749	0.056523	3.020874	0.0086
D (URBAE)	-0.074567	0.064543	-1.155303	0.2660
D (URBAE (-1))	0.191715	0.084815	2.260391	0.0391
D (URBAE (-2))	0.172276	0.082815	2.080251	0.0551
D (GRFDIAE)	0.000043	0.000014	3.049393	0.0081
D (LNDIAE)	-0.004758	0.003751	-1.268740	0.2239
D (LNENCO)	4.505704	0.927036	4.860333	0.0002
D (LNENCO (-1))	-2.032193	0.995961	-2.040434	0.0593
D (LNELPRO)	-0.124706	0.094970	-1.313105	0.2089
D (LNELPRO (-1))	0.015317	0.058281	0.262813	0.1633
D (LNGCON (-1))	0.059269	0.042943	1.380193	0.1878
D (LNGCON (-2))	-0.032118	0.027129	-1.183913	0.2549
D (LNELCUS)	-0.220850	0.101550	-2.174792	0.0461
D (LNELCUS (-1))	0.246956	0.093237	2.648691	0.0182
D (LNELPR))	-0.154700	0.038407	-4.027876	0.0011
D (LNELPR (-1))	0.104399	0.044348	2.354070	0.0326
D (LNELPR (-2))	-0.176946	0.048500	-3.648331	0.0024
D (INFR)	-0.000739	0.000710	-1.041897	0.3140
D (PtDumm)	0.204517	0.086047	2.376813	0.0312
D (DtDumm)	-0.046028	0.024718	-1.862082	0.0823
CointEq (-1)	-0.601298	0.124803	-4.817981	0.0002

Cointeq = LNRGDP- (0.2840*LNELCON + 0.4813*URBAE + 0.0001*GRFDIAE - 0.0079*LNDIAE + 4.1136*LNENCO -0.2074*LNELPRO +0.3281*LNGCON + 0.0434*LNELCUS - 0.3779*LNELPR -0.0012*INFR +0.3401*PtDumm -0.0765*DtDumm -32.3574)

R-squared	**0.943781**	**Mean dependent var**	**0.050248**
Adjusted R-squared	0.919044	S.D. dependent var	0.073870
S.E. of regression	0.021018	Akaike info criterion	-4.630256
Sum squared reside	0.011044	Schwarz criterion	-4.107796
Log-likelihood	97.65973	Hannan-Quinn criteria	-4.446064
F-statistic	38.1535	Durbin-Watson stat	1.905882
Prob(F-statistic)	0.000000		

Source: Own Computation with Eviews-11(2020)

For the study diagnostic checkups such as tests for serial correlation, normality, and alternative tests for heteroskedasticity were developed. To test the stability of Long run cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares residuals (CUSUMSQ) were used. Top qualified diagnostic tests Chow test and Zivot-Andrews test were conducted to check the structural break model.

Serial correlations computed value of F-statistics and Obs*R-squared were above standard 5% significant level of the p-value. This is good to reject the null hypothesis. The P-value associated with to test statistic was greater than the standard significant (i.e., 0.8700>0.05 and 0.7865>0.7865). Godfrey LM-testing for serial correlation is applied.

Jarque-Bera and probability are applicable to check histogram-normality. This test is sufficient to reject the null hypothesis of residual in models that are not normally and independently distributed. The conclusion of residual terms was normally and independently distributed based on the determined value of Jarque-bera and computed probability value (5.290 >0.05, 0.070 > 0.05) respectively.

The diagnostic for heteroskedastic was carried out that the study could not obtain evidence of rejecting null hypotheses such as Breusch-pagan-Godfrey, Harvey, Glejser, ARCH, and white. This test was carefully checked up heteroskedasticity option tests to detect the problem. Therefore, all p-value associated with each test statistics and chi-square were identified to be larger than the standard significance level (0.8936>0.05, 0.2205>0.05, 0.8673>0.05, 0.4610>0.05, and 0.9154>0.05) for each of Godfrey, found Harvey, Glejser, ARCH, and white heteroskedasticity tests respectively.

Test for model stability was developed on instabilities problem to reject the null hypothesis. The result mentioned that the estimated ARDL model and p-value were obtained from statistical tests and standardized ones (0.3140>0.05). The developed ARDL model was a well and correctly specified functional form. ARDL model was free from serious parameters instability, CUSUMSQ of the corrected model with dummies and model is completely stable.

For the developed Chow test and structural break, the value of F-statistics was greater than the standardized p-value 0.05 for all series. The P-value for log-likelihood ratio and Wald statistics became above standard P-value this leads to the same conclusion with F – statistics. Therefore, all summary statistics failed to reject the null hypothesis of no breaks at specified breakpoints for each series.

To test different structural breaks quadrant Andrews test for the structural break was developed. Andrew test was carried out to test a structural break for unknown structural breakpoints among all regressor in estimation. Wald F-statistics (0.0975), LR F-statistics (0.2140) were greater than the p-value of 5% level of significance. These failed to reject the null hypothesis of no structural break at 30% and 35% within 15 and 11 possible numbers of a break compared respectively.

4. Conclusions and Policy Implications

4.1 Conclusion

This study principally aimed to investigate the effect of electricity consumption on Ethiopian economic growth. Electricity consumption is pinpointed as one of the main motivators and being a pillar for modern economies. Auto-Regressive Distributed Lag (ARDL) model was developed to analyze short-run and long-run relationships. Alternative unit root tests and fractional integration unit root tests were conducted to test the long memory of dependency series. Urbanization and foreign direct investment were positively correlated with economic growth. The weak magnitude of foreign direct investment and domestic investment attract foreign direct investment inflow. Aggregate energy consumption per capita was significant both in the short-run and long-run. Coefficients aggregate energy consumption per capita was found to have a strong positive correlation with economic growth whereas the rate of inflation and drought time indicator were negatively correlated. The speed of adjustment indicated that 60.12% of the short-run adjustment is made per year towards long-run equilibrium. Without a strong electricity supply by the concerned body, the electricity demand might not be decline by swiftly promoting urbanization and inviting more foreign investors.

4.2 Policy Implications

Given these findings, several implications could emerge from the analysis upon which important suggestions could be made as key recommendations. Unstable and inadequate electricity supply leads the country to significant loss on a certain amount of GDP. The government of Ethiopia and concerned bodies should formalize the spread out of electricity supply which is a key for income generation in an urban area. Effective implementation and regulation of limited electric supply ensure sustainable economic growth in the long run. The Ethiopian electricity sector better designed sustainable electricity wastage control and integrated monitoring in electricity generation, supply, and consumption to minimize power loss. It is better to attract foreign direct investment policymakers through considering more active measures such as low-cost availability of electricity by stabilizing the tariff in electricity price both in the short-run and long-run. Ethiopian energy policymakers better reinforce and boost the existing energy policy by checking up on previous policy in terms of adequacy. Lowering the inflow level of rivers and rainwater into the hydroelectric dams is a key to controlling electricity crisis such as shortage of power supply and raises in the demand which in turn diminishes electricity consumption and annual GDP.

5. Acknowledgments

The authors would like to extend their gratitude to the national bank of Ethiopia, the ministry of finance and economic cooperation, Ethiopian electricity sectors, ministry of water resource, irrigation, and energy, Ethiopian central statistical agency office, and staff there for the secondary data and unreserved support they provided to the study.

References

Borozan D. Testing for Convergence in Electricity Consumption Across Croatian Regions at the Consumer's Sectoral Level. Energy Policy. 2017; 102:145 –153.

Desire W. The Relationship Between Electricity Consumption, Foreign Direct Investment, and Economy: Case of Benin. International Journal of Energy Economics and Policy. 2020; 10(4): 507.

Esen Ö. Does More Energy Consumption Support Economic Growth in Net Energy-Importing Countries? 2017; 22(42):75–98.

Carrera, Jorge E, Mariano F, Demian P. Testing the Order of Integration with Low Power Tests. An Application to Macro-Variables. Journal of Applied Economics. 2003; 6(2): 221– 246.

Lütkepohl H. Recent Advances in Cointegration Analysis. 2004:107 – 146.

Hundie S. Modelling Energy Consumption, Carbon Dioxide Emissions and Economic Growth Nexus in Ethiopia: Evidence from Cointegration and Causality Analysis. Turkish Journal of Agriculture – Food Science and Technology.2018 6(6): 699.

Wooldridge J. In Introductory Econometrics 6th Edition. 2016: 277.

Gujarati N. In Basic Econometrics, 4th Edition, The McGraw-Hill Companies. 2004: 819.

Faisal F, Turgut T, Nil GR, Niyazi B. Electricity Consumption, Economic Growth, Urbanization and Trade Nexus: Empirical Evidence from Iceland. Economic Research-Ekonomska Istrazivanja. 2018; 31(1): 664 – 680.

Nguyen H, Ngoc HB, Duc HV, Michael M. Energy Consumption and Economic Growth: from Vietnam. Journal of Global Economics. 2019; 8: 350 – 361.

Marinaş M, Marin D, Aura GS, Cristian S. Renewable Energy Consumption and Economic Growth. Causality Relationship in Central and Eastern European Countries. PLoS ONE. 2018; 13(10): 1–29.

Al-khawaldeh M, Ali Mustafa A. The Effect of Energy Consumption on Economic Growth in Jordan. International Journal of Academic Research in Accounting, Finance and Management Sciences. 2018; 8(2): 170 – 177.

Pesaran M, Hashem Y, Richard J. Bounds Testing Approaches to the Analysis of Level Relationships. Journal of Applied Econometrics. 2001; 16(3): 289–326.

Hussain H, Milad A, Aimi Z, Abdul R. Environmental Impact of Sectoral Energy Consumption on Economic Growth in Malaysia: Evidence from ARDL Bound Testing Approach. 2019; 28(107): 199–210.

Burke, Paul J, David IS, Stephan BB. The Impact of Electricity on Economic Development: A Macroeconomic Perspective. International Review of Environmental and Resource Economics. 2018; 12(1): 85–127.

Eggoh JC, Chrysost B, Christophe R. Energy Consumption and Economic Growth Revisited in African Countries. Energy Policy. 2011; 39(11): 7408 – 7421.

Muhammad K, Nur-Syazwani M. The Impact of Electricity Consumption on Economic Growth in Malaysia: Evidence from ARDL Bounds Testing. Jurnal Economic Malaysia. 2018; 52(1): 223 – 233.

Nkoro, Emeka, Aham KU. Autoregressive Distributed Lag (ARDL) Cointegration Technique. Journal of Statistical and Econometric Methods. 2016; 5(4): 63–91.

Otero J, Christopher FB. Response Surface Models for the Elliott, Rothenberg, and Stock Unit-Root Test. Stata Journal. 2017; 17(4): 985–1002.
Owusu, Phebe A, Samuel AS. A Review of Renewable Energy Sources, Sustainability Issues and Climate Change Mitigation. Cogent Engineering. 2016; 3(1): 1–14.
Ozturk I. A Literature Survey on Energy-Growth Nexus. Energy Policy. 2010; 38(1): 340 – 349.
Rao B. Estimating Short and Long-Run Relationships: A Guide for the Applied Economist. Applied Economics. 2007; 39(13): 1613 – 1625.
Zaman, Mudassir, Farzana S, Azad H, Sadia Q. Examining Relationship between Electricity Consumption And Its Major Determinants in Pakistan. 2015; 5(4): 998–1009.
Tamba, Jean G, Jean LN, Armand FL, Flavian ES. Electricity Consumption and Economic Growth: Evidence from Cameroon. Energy Sources, Part B: Economics, Planning, and Policy. 2017; 12(11): 1007 – 1014.
Sama M. The effect of Energy Consumption on Economic Growth in contribution / Originality/. 2016; 6(9): 510 – 521.
Shahid A. Impact of Electricity Consumption on Economic Growth: An Application of Vector Error Correction Model and Artificial Neural Networks. Repec: Jda. 202; 54(4): 89 – 104.