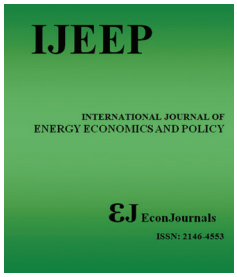

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Information Communication Technology, Electricity Consumption and Economic Growth Nexus in Botswana

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ABSTRACT

When discussing economic growth, electricity consumption and information and communication technology are both crucial components. Effective resource allocation is made feasible by ICT, which raises demand and drives down prices. Electricity, on the other hand, is critical to modern life since it powers industries, technologies, and necessary services, improving living standards and facilitating social and economic growth. The study aims to assess how ICT, electricity consumption, and economic growth are related in Botswana. This study investigates whether there is a causal link between ICT, power use, and economic expansion. In order to assess the nexus relationship, the study used the autoregressive distributed lag model. The findings showed that ICT has a long-term beneficial impact on economic growth, while economic growth has a long-term negative impact on ICT. The study also demonstrated directional causality between electricity use and ICT. This implies that rising electricity consumption raises the need for electricity, which in turn raises ICT investment. It was discovered that Botswana's economic growth was negatively impacted by education. Long-term economic growth in Botswana is enhanced by a rise in industrial expansion. A two-way causal relationship between ICT and electricity use was also demonstrated; as electricity use rises, so does the demand for ICT investment, which in turn raises ICT investment. The study recommends that in the diversification thrust of Government of Botswana, electricity and ICT should be given priority since they can be catalyst for economic growth in the long run.

Keywords: Information Communication Technology, Electricity, Economic Growth, Education, ARDL
JEL Classifications: O2, O3, O5

1. INTRODUCTION

Electricity and information and communication technology are both important factors in discussions of economic growth. ICT makes it possible to allocate resources efficiently, lowering prices and increasing demand. Information and communication technology is widely recognized for its contribution to economic progress (Aghaei and Rezagholizadeh, 2017; Sağlam, 2018; Edquist and Henrekson, 2017). It is now becoming a crucial component in building a nation's capacity for production in every area of the economy, connecting it to the rest of the world, and guaranteeing competitiveness. ICT facilitates economic growth by expanding the use of technologies like computing, mobile broadband, and high-speed Internet; these technologies in and of themselves generate growth, and the fact that they facilitate communication and increase worker productivity generates further advantages.

Powering industries and maintaining economic activity require electricity (Ogundipe, 2013; Mezghani and Haddad, 2017; Gurgul and Lach, 2012). One of the essential infrastructure components for socioeconomic development, electricity has served as the

cornerstone of economic expansion. Powerful factors like population expansion, widespread urbanization, industry, and rising living standards are driving the world's electricity demand. Economic growth and power use are strongly correlated, according to the majority of studies. Ferguson et al. (2000) looked at the problem in more than 100 nations and discovered that, generally speaking, there is a substantial link between economic growth and power use. In the current economic environment, a nation's capacity to expand and, consequently, attain economic prosperity is significantly influenced by its electrical supply infrastructure. It is widely believed that economic expansion will lead to a rise in the use of electricity (Yoo and Lee, 2010).

The current study uses Botswana to evaluate the nexus among ICT, electricity use and economic growth. Historically, sound economic institutions and smart macroeconomic policies have served as the foundation for Botswana's macroeconomic policy framework, especially when it comes to handling diamond money (World Bank, 2024). It has helped the economy grow favourably for a long time. However, because diamonds account for more than 90% of all exports and constitute a significant source of fiscal revenue, Botswana's economy has become more susceptible to external shocks over time due to its reliance on the commodity and its public sector-driven model. The economy is vulnerable to global shocks due to its reliance on the capital-intensive mining sector, which also has poor ties to the rest of the economy (World Bank, 2024). Due to a drop in diamond production and prices brought on by a weakened worldwide demand, growth is predicted to decrease to 1% in 2024 from 2.7% in 2023. Over the medium future, growth will marginally increase due to the efforts to diversify the economy and the expansion in the demand for diamonds worldwide (World Bank, 2024). Since energy in the form of electricity is a crucial component of production in Botswana, this will subsequently necessitate an expansion of the energy supply to meet the rising demands to support the diversified economy (Chingoiro and Mbulawa, 2017; Sekantsi and Timuno, 2017). More than 80% of Botswana's electricity currently comes from coal. As illustrated, the power development plan for 2020-2040 calls for a rise in local electricity output from a variety of sources, including coal (Maswabi et al., 2021).

On the other hand, the government of Botswana strives to have a universally competitive, knowledge and information society where developments in social, economic and cultural development are achieved through effective use of ICT. These have long been acknowledged by Botswana as being essential to diversification. Botswana has established the ICT framework for carrying out its long-term transformative vision over the last few decades (UNCTAD, 2021). This included funding the construction of its ICT infrastructure, liberalizing the telecommunications industry, passing important legislation to establish a favorable ICT legal and regulatory environment, modernizing the public sector's IT, launching significant e-government projects, launching population-wide ICT education and literacy campaigns, and increasing the ability to use ICT technologies to promote sustainable economic development, provide its citizens with life-enriching information and services, and stimulate economic diversification (UNCTAD, 2021).

Given the above background, the study seeks to evaluate the nexus between ICT, electricity use and economic growth in Botswana. In this paper we examine if a causal relationship between ICT and economic growth, electricity use and economic growth, and ICT and electricity use. The study is novel in that it is the first to the researcher's knowledge to look at the nexus between ICT, electricity use and economic growth in Botswana. The study employs the ARDL methodology which is unique in that it is able to ascertain the relationships in both the short and long run. Botswana government thrust to enhance ICT usage in the whole of government makes such a study important as it can inform policy on whether investment in ICT and electricity generation can enhance economic growth which has been retarding over the past few years.

2. LITERATURE REVIEW

Numerous empirical researches have been undertaken to investigate the impact of ICT on economic growth, and the literature review on the subject concludes that ICT is one of the primary factors impacting economic growth. The results show that the debate on the causal effect of electricity and economic growth is inconclusive with causality having been established in some studies while others have failed to establish any causality. This section details some of the study followed by studies on the effect of electricity usage on economic growth.

According to new growth theories, investments in information and communication technology play a major role in economic growth processes (Aghaei and Rezagholizadeh, 2017). Depending on the research methodology used and the geographic configuration taken into consideration, empirical studies have yielded inconsistent findings, despite economic growth theories' predictions that investments in information and communication technology will fuel economic growth. Several theories have been advanced on the relationship between ICT and economic growth. These include the supply-leading hypothesis, demand-following hypotheses, and the feedback loop hypothesis. The supply leading hypothesis argue that new production opportunities and business practices brought about by ICT developments propel economic growth (Saglam, 2018; Edquist and Henrekson, 2017). While the Demand-Following hypothesis argue that economic growth generates need for improved ICT infrastructure, which in turn drives up ICT investment due to expanding economic demands. Lastly, the feedback loop hypothesis shows that there is a feedback loop between ICT and economic growth, with more ICT investment generating more economic activity, which in turn fuels demand for even more sophisticated ICT (Niebel, 2018; Aghaei and Rezagholizadeh, 2017).

The transmission pathways through which ICT influences economic growth have been the subject of studies. Openness, FDI inflows, education, domestic investment, political institutions, and inflation were among the pathways that Awad and Albaity (2022) looked at. It was determined that the key factors via which ICT penetration indirectly boosted per capita growth in the SSA region were education, openness, and domestic investment. In a similar vein, Bahrini and Qaffas (2019) assessed how information

and communication technology (ICT) affected the economic development of a few developing nations in Sub-Saharan Africa (SSA) and the Middle East and North Africa (MENA) region. The results show that, aside from fixed telephones, the primary forces behind economic growth in developing nations in MENA and SSA are other ICTs including mobile phones, Internet use, and broadband adoption.

Information and communication technology's effect on economic growth was compared across developing, emerging and developed countries (Niebel, 2018). The primary query is whether developing, emerging, and developed nations see different returns on their ICT investments. The output elasticity of ICT does not differ statistically significantly among the developing, emerging, and developed country subsamples, according to the data. Accordingly, the findings show that investments in ICT do not yield greater returns for developing and rising nations than for developed ones. Similarly, Appiah-Otoo and Song (2021) conducted a comparative study of the rich and the poor regarding how they might profit the most from the information and communication technology revolution. It was determined by building an ICT index using mobile, internet, and fixed broadband that, while ICT generally boosts economic growth in both nations, poorer nations often benefit more from the ICT revolution. Partial Least Squares was used to assess how ICT affected the economic growth of European nations (Fernández-Portillo et al., 2020). The study is distinct since it uses the PLS-SEM approach and the Digital Economy and Society Index database (DESI) to measure ICT. The study's findings imply that advancements in ICT deployment and use propel the economic expansion of nations that fall under the umbrella of developed European economies. The dynamic relationship between the rapid improvements in information and communication technology (ICT) and the economic growth of the European Union is examined by Magoutas et al. (2024). It evaluates the relationship between notable economic growth and specific ICT metrics. The analysis shows that there is a positive relationship between the GDP index and ICT development. Aghaei and Rezagholizadeh (2017) use a growth model framework and a dynamics and static panel data approach to examine the economies of OIC countries from 1990 to 2014. According to the estimates, ICT investments have a major effect on the economic growth of the nations under consideration. The impact of information and communication technology on GDP growth in Western Balkan nations between 2000 and 2019 is examined by Ibrahimi and Fetai (2022). The results show that while fixed broadband subscriptions and mobile cellular subscribers have a negative impact on GDP growth, fixed telephone subscriptions and internet usage have a positive impact.

Research has also indicated that ICT may have a small or insignificant impact on growth. O'Mahony and Vecchi (2005) presented fresh evidence regarding the effect of information and communications technology (ICT) capital on real output growth using industry data for the United States and the United Kingdom. A positive contribution was not found in the data analysis of the industry panel. We contend that industry heterogeneity, especially in the time dimension, is to blame for this. ICT has a positive and large impact on output growth, according to data from both countries combined and estimated using a dynamic panel data estimation method. The impact of information and communications technology (ICT) on productivity and economic growth in Latin America between 1990 and 2013 is examined by Hofman et al. (2016). A significant portion of the acceleration of economic growth in the United States since 1995 can be attributed to increased investment in ICT. The findings indicate that, at <1-6th of the overall capital contribution, ICT has played a relatively minor influence.

A significant number of studies have been undertaken to ascertain the relationship between electricity consumption and economic growth (Stern et al., 2016; Alley et al., 2016; Xu, 2022; Adegoriola and Agbanuji; 2020; Rahman et al., 2023). The studies on the relationship between electricity consumption and economic growth can be categorised into four strands (Rahman et al., 2023). These theories include (i) the growth hypothesis, which maintained that the use of electricity accelerated economic growth and predicted a causal direction from electricity to economic growth; (ii) the conservative hypothesis, which showed that economic growth increased energy use and that the causal direction shifted from economic growth to electricity; (iii) the neutrality hypothesis, which maintained that there was no causal relationship between economic growth and electricity consumption; and (iv) the feedback hypothesis, which showed a bidirectional causality between economic growth and electricity use (Rahman et al., 2023). Some of the studies are discussed in this section.

Rahman et al. (2023) examined how government policy and electricity use affected economic growth of the four South Asian nations that were chosen between 1980 and 2014. According to the report, South Asia's economic growth benefited greatly from the presence of electricity. The growth hypothesis is supported by the causality test, which shows a unidirectional causal relationship between electricity consumption and economic growth. Xu (2022) evaluated the many causal mechanisms that underlie the relationship between China's economic growth and energy consumption. According to the findings, the relationship between energy consumption and economic growth has grown stronger over time, as have the direct and indirect consequences. The 2020 study by Adegoriola and Agbanuji examines how electricity use affects the Nigerian economy. In the short term, there is a positive and significant correlation between electricity consumption and economic growth, according to the ARDL results. However, over the long term, electricity consumption has a negative and negligible impact on economic growth in Nigeria. The causal relationship between Cameroon's economic growth and electricity usage was assessed (Tamba, 2017). The results show that there is no causal relationship between economic growth and power consumption, nor is there a co-integration relationship between the variables. Furthermore, Granger causality test results established the neutrality hypothesis. Osman et al. (2016) examined the connection between economic growth and energy usage in the GCC countries. The feedback hypothesis is supported by the findings, which showed a bidirectional causal relationship between

these nations' economic growth and power use. This suggests that any energy or electricity conservation measures adopted or put into place by these nations may have a detrimental effect on economic expansion.

A strong correlation between economic progress and the use and accessibility of electricity was ascertained in a study (Stern et al., 2016). This demonstrates how crucial a stable electricity supply is to economic expansion. The transmission channels in the relationship between electricity and economic growth were assessed by Alley et al. (2016). Through its beneficial effects on industrial output, the results demonstrate that electricity has a positive impact on Nigeria's economic growth. Electricity had little direct impact on economic expansion. Iyke (2015) investigates the dynamic causal relationships between Nigeria's economic growth and electricity usage. The findings demonstrate a clear causal relationship between energy use and economic expansion over both the short and long terms. The electricity-led growth hypothesis is supported by this finding. Abdoli (2015) assesses the connection between real GDP, power consumption, and trade activities using the panel cointegration and panel-based error correction approach models and framework. The findings show that there is a long-term correlation between real GDP, electricity use, and trade activities involving import and export. Khalid and Mazlan (2018) investigated the connection between Malaysia's economic growth and energy consumption between 1971 and 2014. According to the findings there was a cointegration between real GDP and electricity consumption. The findings demonstrated that short-term economic growth was positively impacted by electricity use.

3. METHODOLOGY

In this study, we used a multivariate framework to investigate the relationship between economic growth and electricity usage. Because it will support supply-side factors on gross domestic output, the Cobb-Douglas production function was used to build the model. Equation 1 is the general form of production:

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

Where Y is real GDP, A represents technology, while K and L indicate real capital and labour respectively. The current study modifies the works of the above by including other variables such industrial value addition, electricity use, information communication technology and education (proxy for labour). The econometric model adopted is specified as equation 2:

$$GDP_t = \alpha_1 + \alpha_2 EDU_t + \alpha_3 ELEC_3 + \alpha_4 ICT_t + \alpha_5 IVA_t + \varepsilon_t \quad (2)$$

Where, growth in national income is used to proxy economic growth (GDPG). The study integrates the following dependent variables: Industrial value addition, Information communication technology (ICT), Electricity consumption (ELEC). Industrial Value Addition - A strong industrial sector is essentially a major driver of economic growth. This is included as a variable to capture essence of industry as a consumer of both electricity and ICT products. Electricity use (ELEC) and economic growth are generally positively correlated, according to research, so having more access to dependable electricity can have a big impact on economic development by promoting technological advancements, boosting business expansion across industries, and enabling higher productivity in a variety of sectors. Though other studies have shown that the relationship could be negative or insignificant. By increasing productivity, fostering innovation, increasing market efficiency, and opening new business models, information and communication technologies (ICT) significantly boost economic growth. In other words, ICT is a major force behind economic growth in several industries. Since education (EDU) helps people gain information and skills that boost productivity, which raises incomes and fosters innovation and general economic development at the individual and national levels, it has a major positive impact on economic growth.

To assess the effect of electricity use and ICT on economic growth the estimation technique adopted for the study is autoregressive distributive lag model (Pesaran et al., 2001). The method was chosen since it is simple to apply to small samples. When the variables are integrated of order zero and one or a combination of the two orders, the approach can be used (Shrestha and Bhatta, 2018). When variables of higher orders are integrated more than once, it is not relevant. When the sample size is modest, it can be used (Ghatak and Siddiki, 2001). When modeled with suitable lags, the approach overcomes the problems of indigeneity and serial correlation (Pesaran et al., 2001). The ARDL method is useful when estimating the long-run and short-run relationships (Pesaran et al., 2001). The method allows the examination of both the short run and long run effects of Electricity use and ICT on economic growth and causality test of the same in Botswana.

The ARDL technique estimates $(P + 1)^k$ number of regressions to determine the optimal lags for each variable. The highest number of lags to be used is P + 1 and k is the number of variables in the equation. The model is selected based on the Schwartz-Bayesian Criterion (SBC) that uses the smallest possible lag length and is therefore described as the parsimonious model.

The ARDL model for the study is specified in equations 2. The equation incorporates both short-run and long-run dynamics of the variables.

$$\Delta GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \alpha_2 IVA_{t-1} + \alpha_3 ELEC_{t-1} + \alpha_4 ICT_{t-1} + \sum_{t=1}^{p} \theta_t \Delta GDP_{t-1} + \sum_{t=1}^{p} \vartheta_t \Delta IVA_{t-1} + \sum_{t=1}^{p} \mu_t \Delta ELEC_{t-1} + \sum_{t=1}^{p} \varphi_t \Delta ICT_{t-1} \quad (3)$$

$$\Delta ICT_t = \alpha_0 + \alpha_1 ICT_{t-1} + \alpha_2 IVA_{t-1} + \alpha_3 ELEC_{t-1} + \alpha_4 GDP_{t-1} + \sum_{t=1}^{p} \varphi_t \Delta ICT_{t-1} + \sum_{t=1}^{p} \vartheta_t \Delta IVA_{t-1} + \sum_{t=1}^{p} \mu_t \Delta ELEC_{t-1} + \sum_{t=1}^{p} \theta_t \Delta GDP_{t-1} \quad (4)$$

$$\Delta ELEC_t = \alpha_0 + \alpha_1 ELEC_{t-1} + \alpha_2 IVA_{t-1} + \alpha_3 GDP_{t-1} + \alpha_4 ICT_{t-1} + \sum_{t=1}^{p} \mu_t \Delta ELEC_{t-1} + \sum_{t=1}^{p} \vartheta_t \Delta IVA_{t-1} + \sum_{t=1}^{p} \theta_t \Delta GDP_{t-1} + \sum_{t=1}^{p} \varphi_t \Delta ICT_{t-1} \quad (5)$$

Where α_1 to α_7 are long-run parameters and θ, ϑ, μ, ϕ, ω and ϵ are short run parameters. The model hypothesizes that there is no cointegration $[\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7]$ and in case this fails the alternative is $[\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7]$, implying there is cointegration. When the null hypothesis is rejected based on the F-statistic implies there is cointegration. The rejection criterion is premised on the Bounds test.

The cumulative sum of squares of recursive residuals (CUSUMSQ) stability test was used to evaluate the ARDL model's goodness of fit. All the data for the study were obtained from Statistics Botswana. All the data is quarterly data starting from 2007 quarter one to 2023 quarter 1.

4. RESULTS PRESENTATION AND ANALYSIS

This section presents and analyses the results of the study. The descriptive statistics for the variables used to estimate the ARDL models are presented in Table 1. The statistics show that there is little variation in all the variables. Electricity usage has higher variability compared to the other variables. Industrial value addition variable has the second highest variable among the variables.

The correlation coefficients of the study are shown in Table 2. The correlation coefficient represents the linear relationship between two variables hence is used as a guide to check for the presence of multicollinearity. Accordingly, the matrix indicates that there is no strong correlation among the variables. According to Gujarati and Porter (2007), multicollinearity is a problem if the correlation between independent variables is above 0.8. The variables show that there is no correlation coefficient >0.8 hence there is no multicollinearity among the variables. All the independent variables were considered for the regressions.

The current study employed time series to ascertain the nexus between ICT, electricity use and economic growth. In an effort to ensure that there is no spurity among the variables, stationarity test was carried out employing the augmented dickey fuller test. The method was proposed by Dickey and Fuller (1981) and has gained dominance as a unit root test. The test is premised on parametric approach and developed the Dickey-Fuller (DF) approach. The unit root test results are shown in Table 3.

The unit root test shows that all the variables are integrated of order zero. This means that the variables are stationary in levels. Given that there is no variable which is integrated of order >1, this paves way for the use of ARDL method. The requirement for the validity of the ARDL method is that the variables should be I (0), I (1) or mixture of the two was discussed in the methodology section and has been met for the current study. This then implies that equations 3-5 can be estimated. The results are shown in Table 4.

The long run and short-run results for equation 4, 5 and 6 are reported in Table 4. The coefficient on the lagged error correction terms for the three equations are significant with the correct sign, supporting the evidence of long-run relationship among the variables. This coefficient suggests that a deviation from the long run equilibrium level of output in 1 year is corrected by 92%, 2% and 79% over the following year for the equations with economic growth, ICT and electricity use models respectively. The automatic choice of the models retained ARDL (1,1,0,0,1), ARDL (1,0,0,0,1) and ARDL (1,1,0,0,1) for the economic growth, ICT and electricity use models respectively. The short run and long run results are discussed below.

The results show that ICT has a positive effect on economic growth in the long run. This means that an increase in investment in ICT improves economic growth. This result is important because as economies are turning towards digitalisation of systems, there is going to be greater investment in ICT systems which will boost growth. The results renders support to other prior studies (Awad and Albaity, 2022; Niebel, 2018; Aghaei and Rezagholizadeh, 2017). On the other in the short run ICT has a negative effect on economic growth implying an increase in investment in ICT in the short run harm economic growth. This could be attributed to the role of Information and Communication Technology (ICT) in exacerbating inequality, increasing unemployment, and creating environmental problems mostly in the short run. This result is supported by Abu Alfoul, et al. (2024) who established a negative relationship between economic growth in MENA countries. Further the results have established that economic growth negatively affect ICT both in the short run and long run. This means an increase in economic growth leads to a decline in investment in ICT. This means as Botswana economy grows, the amount of investment in ICT starts to decline in both the short run and long run. Literatures shows that while generally ICT investment and economic growth are linked, a period of strong economic growth might paradoxically see a decrease in ICT investment because existing ICT infrastructure might become sufficient, leading to a lower need

Table 1: Descriptive statistics

Statistic	GDP	ICT	ELEC	IVA	EDU
Mean	3.1895	8.0930	16.7781	3.1404	5.7016
Median	3.7000	5.9000	62.5000	3.1000	5.9000
Maximum	37.8000	27.3000	87.8000	40.6000	26.6000
Minimum	−30.8000	−2.8000	32.0000	−34.8000	−19.7000
Standard deviation	10.5000	6.8043	14.7597	12.5775	9.7792

for new infrastructure and equipment, and because firms may shift their focus to other strategic areas. The result contradicts Magoutas et al. (2024) who established that there is a positive relationship between the GDP index and ICT development. The combined effect of the results in the long run is that there a bi-directional causality running between investment in ICT and economic growth. An increase in economic growth leading to a decline in ICT while this decline might lead to a decline in economic growth.

The results show that education has a negative effect on economic growth in Botswana. An increase in educational spending reduces economic growth in the long run. It is quite interesting to understand that the educational expenditure reduces economic growth because most sub Saharan countries spend the majority of their budgets on education which is not improving the growth narratives in these countries. Botswana spends significant budget allocation to education hence there is need to review how the spending in education can be turned to productive spending so as to increase economic growth. Some studies have shown that the negative effect of education on economic growth is mainly due to the low institutional quality, with less expenditure being allocated to education (Mauro, 1996; Tanzi and Davoodi, 2001).

Table 2: Correlations matrix

	EDU	ELEC	ICT	IVA
EDU	1			
ELEC	0.1619	1		
ICT	0.6319	0.3656	1	
IVA	0.2674	0.1053	0.0743	1

Table 3: Unit root test (YT)

Variable	t-statistic	P-value	I(d)
GDP	−5.6070	0.001***	I(0)
ICT	−3.6097	0.0373**	I(0)
IVA	−5.8335	0.0001***	I(0)
EDU	−6.552	0.0001***	I(0)
ELEC	−4.3227	0.0074***	I(0)

The study shows that industrial value addition as measured by contribution of manufacturing to economic growth has a positive effect on growth both in the short and long run. An increase in industrial growth improves economic growth in Botswana in the long run. Industrial growth has a significant positive impact on economic growth because it results in increased productivity, job creation, technological advancement, and higher production of value-added goods, all of which contribute to a country's overall GDP. According to empirical findings, economic growth and industrialization are positively correlated in the short and long run (Bokosi, 2022).

The results reveals that electricity usage has a positive effect on ICT in the long run. An increase in electricity usage leads to an increase in ICT. The results make great sense because the use of ICT is dependent on electricity available. Most schools and social infrastructure are only able to invest in ICT equipment only when there are connected to the electricity grids. Without electricity, it is difficult or of no use to invest in digitalisation. On the other hand, ICT has a positive effect on electricity usage, implying that as investment in ICT increases electricity usage also increase. This result is important as it shows that there is directional causality between ICT and electricity usage. This means an increase in electricity usage increases the demand for electricity which also leads to an increase in investment in ICT. This then calls for increased availability of electricity to ensure continued investment in ICT in Botswana.

Economic growth has a positive effect on electricity usage. An increase in economic growth enhances electricity usage. This means as an economy starts growing, the demand for electricity usage by the citizens and industry also increases. Similar results of a strong relation between economic progress and the use and accessibility of electricity was ascertained in a study (Stern et al., 2016) which demonstrated how crucial a stable electricity supply is to economic growth. The study results show that there is unidirectional causality between economic growth and electricity usage. This causality runs from economic growth to electricity use.

Table 4: ARDL regression results

Dependent variable	Dependent: GDPG	Dependent: ICT	Dependent: ELEC
Independent variable	Coefficient (P-value)	Coefficient (P-value)	Coefficient (P-value)
GDPG		−1.6933* (0.0648)	4.4687** (0.0242)
GDPG(−1)	0.0756 (0.6552)	−1.4121*** (0.0065)	1.6489*** (0.0010)
ICT	0.0566* (0.0898)	-	0.9316** (0.0144)
ICT(−1)	0.0650* (0.0529)	0.9726*** (0.0000)	−0.8696** (0.0270)
EDU	−0.0108* (0.0874)	−0.0198 (0.5670)	3.3119 (0.6584)
EDU(−1)	-		
ELEC	0.0261 (0.1078)	0.0002** (0.0141)	
ELEC(−1)	-		0.2016 (0.2381)
AIVA	0.8141*** (0.0000)	1.9627** (0.0139)	−3.3798* (0.0603)
AIVA(−1)	−0.2561 (0.0535)		-
Short run model			
D(GDPG)	-	−1.6933*** (0.0060)	0.4468*** (0.0024)
D(ICT)	−0.0566 ** (0.0364)		0.7763*** (0.0024)
D(EDU)			
D(ED)			
D(ELEC)			
D(IND)	0.8141*** (0.0000)		
Cointeq(−1)	−0.9241*** (0.0000)	−0.0274*** (0.0000)	−0.79830*** (0.0000)
Model	ARDL (1,1,0,0,1)	ARDL (1,0001)	ARDL (1,1,0,0,1)

*, **, *** significant at 10%, 5%, 1%

Industrial growth has a positive effect on ICT investment. This means that an increase in industrial value addition increases the demand for ICT. Industrial growth significantly impacts ICT by increasing the demand for ICT products and services, driving innovation, and fostering digital transformation, ultimately leading to greater efficiency, cost reduction, and economic growth across various sectors.

5. CONCLUSION

Electricity and information and communication technology are critical elements of economic growth. ICT enables effective resource allocation, which reduces costs and boosts demand. Electricity is vital to modern life, sustaining industries and vital services that raise living standards and stimulate economic progress. The study evaluated the nexus among electricity, ICT and economic growth. An evaluation of the relationships among the variables has shown that there is bidirectional relationship between ICT and economic growth; and ICT and electricity use. There is only a unidirectional effect from economic growth to electricity use. The nexus between ICT and economic growth are not reinforcing since there is opposite effect with ICT negatively affecting growth while economic growth positively impacts ICT, which calls for cautious approach and requires further investigation. Industrial value addition positively impacts economic growth, which is important for diversification of the economy. Given the overreliance on diamonds, the new thrust should ensure new industries are developed. These would then require the ICT services and increased electricity usage. This would then help grow the economy. The government should therefore encourage new entrants into the ICT sector and electricity generation since these can drive economic growth. Further studies could look at these relationships using longer time spans and also from a regional perspective. This would be important because the SADC region is currently facing serious challenges in electricity generation.

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