IS THERE A RELATIONSHIP BETWEEN ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN ZIMBABWE?

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Abstract

This paper investigated the causality relationship between electricity consumption and economic growth in Zimbabwe using a bi-variate time series framework for the period 1980 to 2011. The causality relationship between the two variables has been a subject of extensive debate for decades among economists and academics. There are four dominant perspectives with regard to the causality relationship between electricity consumption and economic growth. The first perspective maintains electricity consumption spur economic growth whilst the second perspective argues that it is economic growth that drives electricity consumption. The third perspective suggests that both electricity consumption and economic growth promotes each other whilst the fourth perspective argues that there is no causality relationship at all between the two variables both in the short and long run. Using the bi-variate causality test framework, this study failed to establish any direct causality relationship between energy consumption and economic growth. The results imply the existence of an indirect bi-directional causality relationship between the two variables. The study therefore recommends Zimbabwe authorities to address indirect factors that have a bearing on economic growth over and above scaling up investment efforts into electricity production capacity improvement infrastructure.

Keywords: Zimbabwe, Electricity Consumption, Economic Growth, Bi-variate Time Series Framework

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1. Introduction

There has been a growing interest in research on the relationship between electricity consumption and economic growth triggered by increased demand for energy across the whole world (Narayan and Prasad, 2008). These empirical studies began since the research work by Kraft and Kraft (1978). However, these previous studies show no consensus in as far as the direction of causality between the two variables is concerned. Some previous researchers on this area established that electricity consumption positively drive economic growth and these include, Narayan and Singh (2007), Shahbaz and Lean (2012), Kouakou (2011), Yuan et al (2007), Ouedraogo (2010), Akinlo (2009), Abosedra et al (2009), Squalli (2007), Altinay and Karagol (2005), among others. Past empirical analysts who established an opposite finding that it is economic growth that spur electricity consumption include Narayan and Smyth (2005), Chen et al (2007), Ciarreta and Zarraga (2010), Mozumder and Marathe (2007), Kouakou (2011), Rufael (2006), Apergis and Payne (2011), Hossain and Saeki (2011), among others.

However, another group of researchers discovered that both electricity consumption and economic growth promotes each other. Studies that are consistent with this view were done by Narayan and Smyth (2009), Chen et al (2007), Shahbaz and Lean (2012), Kouakou (2011), Tang (2008), Yoo (2005), Odhiambo (2009), among others. Finally, Acaravci and Ozturk (2010), Narayan and Prasad (2008), Chen et al (2007), Hossain and Saeki (2011), among others discovered no causality relationship at all between electricity consumption and economic growth. This reveals that the disagreements and contractions on the causality relationship between electricity consumption and economic growth is far from over. The major aim of this research is to fill this gap in the literature.

According to (Shahbaz and Lean, 2012), majority of these empirical studies focused more on developed countries, Asia and Latin America leaving sub-Saharan African countries with very small attention. In small cases where an investigation of the causality relationship between electricity and economic growth has been done sub-Saharan African countries, panel data analysis has been employed (see Rufael, 2006). It is against this backdrop that the current study focuses on investigating the validity of the electricity consumption-led growth perspective in Zimbabwe using the bivariate causality test framework. Since Zimbabwe is the only country involved in this study, country-specific differences

normally found in studies using pooled data sets is going to be overcome (see Chandran et al, 2010). The involvement of Zimbabwe alone in this study enables aspects like structural, policy reforms and institutional factors of Zimbabwe to be taken care of in the interpretation of the findings (see Chandran et al, 2010). Above all, to the best of the author's knowledge, such a study is the first of its kind to focus specifically on Zimbabwe.

The study is of paramount importance for formulation of policy purposes (see Narayan and Smyth, 2005; Ghosh, 2002). Findings from this research will help Zimbabwe economic policy makers to design correct electricity consumption policies that will have long run positive impact on the economy of Zimbabwe. According to Acaravci and Ozturk (2010), the shortage of electricity negatively impact on economic performance if causality runs from electricity consumption to real GDP. However, electricity conservative policies for example electricity rationing does not negatively affect economic performance either if there is no causality at all between electricity consumption and economic growth or if the causality exists but running from electricity consumption to economic growth, further argued Acaravci and Ozturk (2010).

The remaining portion of the study is organized as follows: part 2 reviews both related theoretical and empirical literature whilst part 3 looks into the trends of electricity consumption and economic growth in Zimbabwe. Part 4 looks at data and econometric models while part 5 provides concluding remarks.

2. Theoretical and Empirical Overview of Electricity Consumption and Economic Growth.

Four dominant perspectives on the causality relationship between electricity consumption and economic growth are discussed in this article. The first perspective mentions that electricity consumption positively impact on economic growth. Studies whose results concur with this perspective include those carried out by Narayan and Prasad (2008), Chandran et al (2010), Chen et al (2007), Narayan and Singh (2007), Shahbaz and Lean (2012), Kouakou (2011), Yuan et al (2007), Ouedraogo (2010), Akinlo (2009), Abosedra et al (2009), Squalli (2007), Altinay and Karagol (2005), among others. Narayan and Prasad (2008) revealed that electricity consumption positively influenced real GDP in Iceland, Italy, Czek Republic, Korea, Portugal, United Kingdom, Australia and Slovak Republic both in the short and long run. Using the newly developed autoregressive distributed lag (ARDL), Chandran et al (2010) established the existence of a significant positive causality relationship running from electricity consumption to real GDP in Malaysia. Chen et al (2007) discovered findings that agree with Chandran et al (2010) in a study using data from Indonesia.

Using a multivariate framework, Narayan and Singh (2007) found out that Fiji Islands is an energy reliant country as their study showed a uni-directional causality relationship running from electricity consumption and labour to GDP. As a result, electricity conservation policies in Fiji will curtail economic growth and development, argued Narayan and Singh (2007). Shahbaz and Lean (2012) and Kouakou (2011) discovered results that concur with other electricity consumption-led growth proponents in the long run in Pakistan and Cote d'Ivoire respectively. Moreover, Yuan et al (2007) established a uni-directional Granger causality relationship running from electricity consumption to real GDP in China both in the short and long run without any feedback. In a study that focused on Burkina Faso, Ouedraogo (2010) concurred with Yuan et al (2007) only in the long run. Specifically, economic growth was found to have been Granger caused by electricity consumption in the long run in Burkina Faso according to a study by Ouedraogo (2010). The latter recommended Burkina Faso to craft electricity generation and usage policies that guarantees long run economic growth since it is an energy reliant country.

In a study for the period 1980 to 2006, Akinlo (2009) established a very significant uni-directional Granger causality relationship running from electricity consumption to real gross domestic product in Nigeria. Akinlo (2009) recommended Nigeria to heavily invest in electricity generation and reducing inefficiency in electricity consumption in order to spur sustainable economic growth. Using the bivariate vector autoregression framework, the study by Abosedra et al (2009) further confirmed the existence of uni-directional causality running from electricity consumption to economic growth in Lebanon. Lebanon authorities should strive to invest more in building capacity and electric power infrastructure development in order for the country to realize long term and sustainable economic growth, suggested Abosedra et al (2009). Squalli (2007) concurred with Abosedra et al (2009). Economic growth heavily relied on electricity consumption in five Organisation of Petroleum Exporting Countries (OPEC) countries (Indonesia, Nigeria, Qatar, Iran and Venezuela), less dependent in three OPEC countries (Algeria, Iraq and Lybia), revealed (Squalli (2007). The latter also discovered no relationship at all in three other OPEC countries (Kuwait, UAE and Saudi Arabia) between the two variables. In a study on Turkey, Altinay and Karagol (2005) found out that electricity consumption was one of the factors that positively influenced real GDP. For Turkey to realize long term and sustainable economic growth, electricity production and consumption has to be scaled up, argued Altinay and Karagol (2005).

The second perspective states that economic growth promotes electricity consumption and studies consistent with this view include those undertaken by Narayan and Smyth (2005), Chen et al (2007),

Ciarreta and Zarraga (2010), Mozumder and Marathe (2007), Kouakou (2011), Rufael (2006), Apergis and Payne (2011), Hossain and Saeki (2011), among others. Using the cointegration and causality framework, Narayan and Smyth (2005) revealed that real GDP and employment significantly Granger caused electricity consumption in the long run in Australia. A weak uni-directional Granger causality running from real GDP to electricity consumption in the short run was also revealed by Narayan and Smyth (2005) in Australia. Using panel data analysis, Chen et al (2007) discovered results that agree with the growth-led electricity consumption hypothesis. Specifically, Chen et al (2007) revealed a uni-directional causality relationship running from economic growth to electricity consumption in the short run in all 10 Asian countries that were part of the study. The study by Chen et al (2007) using single country data set also found out that real GDP Granger caused electricity consumption in the long run in countries like Hong Kong and Korea without any feedback effects.

Using the Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) methodology, Ciarreta and Zarraga (2010) discovered a uni-directional linear causality running from economic growth to electricity consumption in Spain both in the short and long run. The results from a study by Mozumder and Marathe (2007) agreed with the growth-led electricity consumption hypothesis. Specifically, Mozumder and Marathe (2007) discovered a uni-directional causality relationship running from per capita GDP to per capita electricity consumption without any feedback in Bangladesh. In a study on Cote d'Ivoire, Kouakou (2011) like other growth-led electricity consumption proponents, found out electricity consumption to have been Granger caused by economic growth both in the short and long run.

A study by Yoo (2006) using time series techniques revealed the existence of a uni-directional causality relationship running from economic growth to electricity consumption in Thailand and Indonesia without any feedback. Rufael (2006) discovered that in 6 out of the 17 African countries studied, electricity consumption was Granger caused by real GDP. Furthermore, using panel error correction model, Apergis and Payne (2011) revealed findings that agree with the growth-led renewable electricity consumption hypothesis both in the short and long run in all the 16 emerging economies that were part of the study. Hossain and Saeki (2011) concurred with Apergis and Payne (2011) and other proponents of the growth-led electricity consumption hypothesis in a study done for Nepal, India and Pakistan without any feedback except only in Bangladesh.

The third perspective mentions that both economic growth and electricity consumption promotes each other. Studies whose findings agree with this perspective include those done by Narayan and Smyth (2009), Chen et al (2007), Shahbaz and Lean (2012), Kouakou (2011), Tang (2008), Yoo (2005), Odhiambo (2009), among others. Narayan and Smyth (2009) discovered a complimentary causality relationship between electricity consumption and economic growth. In a study on Middle Eastern countries, Narayan and Smyth (2009) established that GDP increased by 0.04 as a result of a 1 percent increase in electricity consumption whilst on the other hand electricity consumption went up by 0.95 percent in direct response to an increase in GDP by 1 percent. A panel data analysis by Chen et al (2007) revealed that both economic growth and electricity consumption promoted each other in all the 10 Asian countries that were under study.

Shahbaz and Lean (2012) suggested that both electricity consumption and economic growth complemented each other in Pakistan both in the short and long run. Electricity rationing programmes curtail economic growth and lower growth rate in turn will reduce the demand for electricity in Pakistan, argued Shahbaz and Lean (2012). The latter recommended Pakistan to develop other sources of energy rather than to solely rely on electricity consumption to boost sustainable economic growth. Kouakou (2011) in a study on Cote d'Ivoire revealed findings that are consistent with the bi-directional causality relationship between electricity consumption and economic growth. Using the Granger causality test, Tang (2008) also discovered results that support the bi-directional relationship between electricity consumption and economic growth in Malaysia. Using data from Korea, Yoo (2005) concurred with Tang (2008) with regard to the bi-directional relationship between electricity consumption and economic growth. The increase in electricity consumption positively influences economic growth and that economic growth in turn boost electricity consumption, argued Yoo (2005). Yoo (2006) using time series techniques investigated the causal relationship and economic growth in the Association of South East Asian Nations (ASEAN) countries which include Indonesia, Singapore, Thailand and Malaysia. Both electricity consumption and economic growth promoted each other in Malaysia and Singapore, revealed Yoo (2006). Moreover, Apergis and Payne (2011) discovered the existence of a bi-directional causality relationship between non-renewable electricity consumption and economic growth both in the short and long run in emerging economies. Using a trivariate causality framework, Odhiambo (2009) established a distinct bi-directional causality between electricity consumption and economic growth in South Africa both in the short and long run. Expansion of electricity generation infrastructure is key in boosting economic growth rate in South Africa, argued Odhiambo (2009).

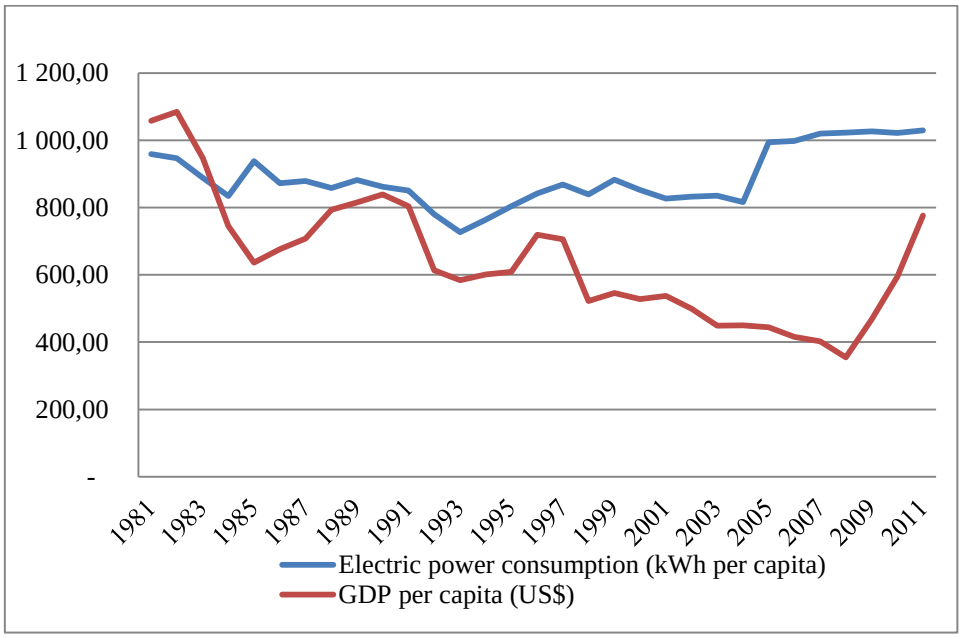
The fourth perspective says that there is no relationship at all between electricity consumption and economic growth. Research work whose results concur with this view include those carried out by

Acaravci and Ozturk (2010), Narayan and Prasad (2008), Chen et al (2007), Hossain and Saeki (2011), among others. Acaravci and Ozturk (2010) discovered no cointegration between electricity consumption and real GDP in 15 transition countries which include Albania, Czech Republic, Belarus, Bulgaria, Latvia, Estonia, Ukraine, Slovak Republic, Serbia, Lithuania, Macedonia, Moldova, Poland, Romania and Russian Federation. Electricity consumption policies do not have any impact on real GDP in the 15 transition countries both in the short and long run, argued, Acaravci and Ozturk (2010). Moreover, Narayan and Prasad (2008 established no causality relationship in 22 OECD countries excluding Iceland, Italy, Czek Republic, Korea, Portugal, United Kindom, Australia and Slovak Republic both in the short and long run. The study by Chen et al (2007) using single country data set also failed to find any causality relationship between economic growth and electricity consumption both in the short and long run in Singapore, India, Thailand and Taiwan. A study by Hossain and Saeki (2011) revealed no causality relationship between electricity consumption and economic growth in Iran and Sri-Lanka both in the short and long run. In a nutshell, majority of the empirical studies supports the electricity consumption-led growth hypothesis.

3. Electricity Consumption and Economic Growth Trends in Zimbabwe

Both electricity consumption and GDP per capita for Zimbabwe recorded mixed trends during the period 1980 to 2011 (see Figure 1).

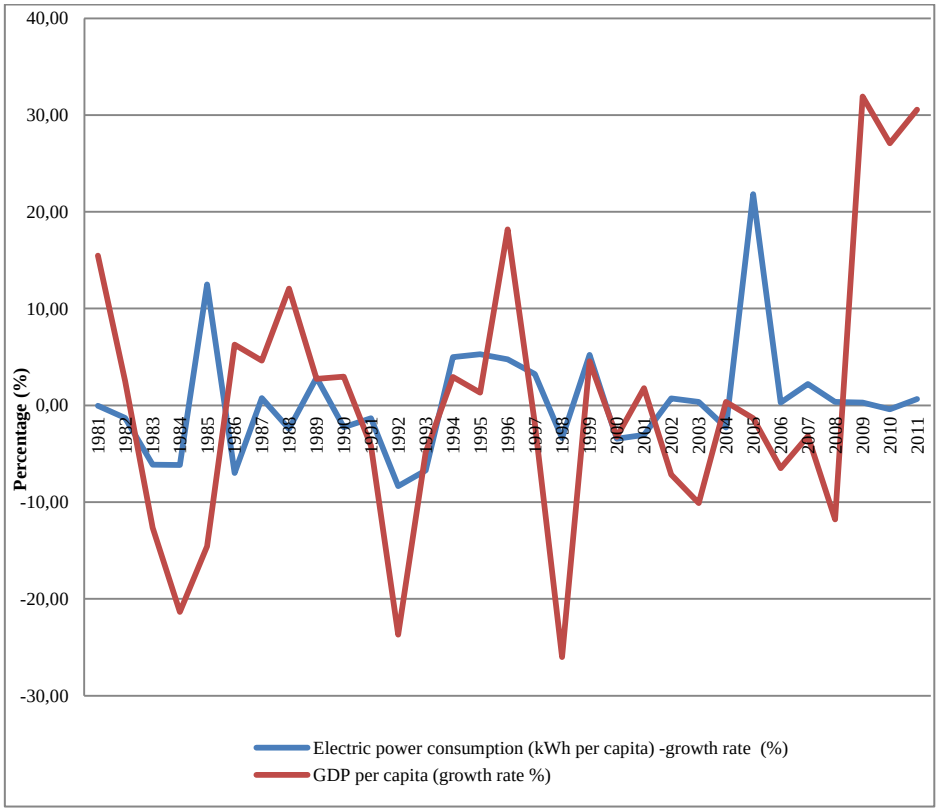
Figure 1. Trends of electricity consumption and economic growth in Zimbabwe (1981-2011)



Source: World Bank (2011)

World Bank (2011) revealed that both electricity consumption (kWh/per capita) and GDP per capita went down by 2% and 31% respectively between 1980 and 1985. This saw electricity consumption going down from 959 kWh/per capita in 1980 to 938 kWh/per capita in 1985 and GDP per capita decreasing from US$916 to US$636 during the same period. The subsequent 10 year period was characterized by a steady decreasing trend in electricity consumption having recorded a negative growth of 8% between 1985 and 1990 and another decline of 7% between 1990 and 1995. Electricity consumption plunged from 938 kWh/per capita in 1985 to 862 kWh/per capita in 1990. According to World Bank (2011), GDP per capita went up by 32% between 1985 and 1990 whilst the next five year period was characterized by a 27% decline in GDP per capita from US$839 in 1990 to US$608 in 1995 (see Figure 2).

Figure 2. Growth rates of electricity consumption and economic growth rates trends for Zimbabwe (1981-2011)



Source: World Bank (2011)

Electricity consumption increased by 6%, from 804 kWh/per capita in 1995 to 853 kWh/per capita in 2000 whilst GDP per capita plummeted US$609 to US$528 during the same period as the economic challenges continued to engulf Zimbabwe. The Zimbabwe economy shrank by a further 16% as represented by a decline in GDP from US$528 in 2000 to US$444 in 2005 whilst 2005 and 2010 was characterized by an economy surge of 34% in GDP per capita. Electricity consumption went up by 3%, from 995 kWh/per capita in 2005 to 1022 kWh/per capita in 2010. However, 2011 saw electricity consumption slightly going up by 0.67% whilst GDP per capita surged by 31% during the same period as the Zimbabwe economy continued picking up.

4. Data and Econometric Techniques

4.1 Data

The study used annual data spanning from 1980 to 2011. The data that was used in this study was obtained from the World Development Indicators. Electric power consumption (kWh per capita) was used as a proxy to measure electricity consumption whilst real GDP per capita was used as a proxy for economic growth. Initially, the data for both variables was auto correlated but the auto correlation was removed by differencing the data once (1st difference).

4.2 Unit root tests

Both real GDP per capita and electric power consumption (kWh per capita) were tested for stationarity before any co-integration and causality test was done. Using Augmented Dick Fuller, both real GDP per capita data and electricity consumption data sets was found to be stationary at 1st difference and intercept as the ADF test statistic was lower than critical values at 1% and 5% (see Table 1). Using Phillips-Perron tests, both electricity consumption and real GDP per capita data was discovered to be stationary at 1st difference and intercept as the PP test statistic was lower than critical values at 5% and 10% (see Table 1).

Table 1. Stationarity Tests of Variables on first Difference

Variable	ADF /PP Test Statistic - Intercept	Critical Values -Intercept	
Stationarity Tests of Variables on first Difference - Augmented Dickey-Fuller - Test			
DPOWER	-6.147374	-4.3226*	-3.5796**
DGDP	-4.944358	-3.6852*	-2.9705**
Stationarity Tests of Variables on first Difference – Phillips-Perron (PP) Test			
DPOWER	-13.13418	-3.6752*	-2.9665**
DGDP	-5.731652	-3.6752*	-2.9665**

Note:
1) * and ** denote 1% and 5% levels of significance, respectively.
2) * MacKinnon critical values for rejection of hypothesis of a unit root.
3) The truncation lag for the PP tests is based on Newey and West (1987) bandwidth.

4.3 Johansen Co-integration Testing Procedure

Having differenced once both the real GDP per capita and electric power consumption (kWh per capita) data to remove the autocorrelation and making the data stationary, the existence of the co integrating vector was investigated using the Johansen Co intergration Testing Procedure. The co integration test is performed to determine the existence of the significant relationship between electricity consumption and real GDP per capita in Zimbabwe.

Table 2. Co-integration Test Results

Eigenvalue	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesized No. of CE(s)
0.38414	23.85619	19.96	24.6	None *
0.286728	9.798863	9.24	12.97	At most 1 **

***** Denotes rejection of the hypothesis at the 1% and 5% levels.
****** Indicates 1 co-integrating equation at 1% and 5% levels.

The author assumed no deterministic trend and intercept (no trend) in the co-integrating equation for both variables because the volatility of the data has already been removed by doing 1st differencing. We reject the null hypothesis that there is no significant long run relationship between electricity consumption and economic growth since Eigen value is less than the critical values. The results show that there is a significant unidirectional long run relationship between the variables.

4.4 Granger causality tests

The next stage was to investigate the Granger-causality between electricity consumption and real GDP per capita since a long run significant relationship between the two variables has been established (see Table 2).

Table 3. Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Probability
DPOWER does not Granger Cause DGDP	29	0.06549	0.93678
DGDP does not Granger Cause DPOWER		0.87761	0.4287

We fail to reject the null hypothesis because the p-values is greater than 0.05 and the F-statistic is less than 4. The results of this study are consistent with the neutrality hypothesis. The study shows that electricity consumption does not cause GDP per capita whilst GDP per capita des not Granger cause electricity consumption as well. The finding contradicts the co-integration results (see Table 2). The contradiction makes it clear that electricity consumption and GDP per capita indirectly promotes each other via other factors in Zimbabwe. According to literature, these indirect variables include among others, government consumption human capital development financial market development and employment.

The empirical findings reported in Table 3 reveal that the null hypothesis should be rejected whilst the alternative hypothesis must be accepted. The results show that electricity consumption significantly Granger-causes economic growth in the long run in Zimbabwe. This finding is confirmed by the statistically insignificant F-statistic and very high probability, hence the rejection of the null hypothesis and acceptance of the alternative hypothesis. GDP per capita weakly Granger causes electricity consumption in the long run in Zimbabwe. This finding is confirmed by the statistically insignificant F-statistic and low probability in the null hypothesis function.

5. Conclusion

This paper investigated the causality relationship between electricity consumption and economic growth in Zimbabwe using a bi-variate time series framework for the period 1980 to 2011. The causality relationship between the two variables has been a subject of extensive debate for decades among economists and academics. There are four dominant perspectives with regard to the causality relationship between electricity consumption and economic growth. The first perspective maintains electricity consumption spur economic growth whilst the second perspective argues that it is economic growth that drives electricity consumption. The third perspective suggests that both electricity consumption and economic growth promotes each other whilst the fourth perspective argues that there is no causality relationship at all between the two variables both in the short and long run. Using the bi-variate causality test framework, this study failed to establish any direct causality relationship between energy consumption and economic growth. The results imply the existence of an indirect bi-directional causality relationship between the two variables. The study therefore recommends Zimbabwe authorities to address indirect factors that have a bearing on economic growth over and above scaling up investment efforts into electricity production capacity improvement infrastructure.

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