Influence of Gas Consumption on Economic Growth in Kenya

Molly Jerono Mercy[1], Dr. Richard Siele[2], Dr. Edwin Kimitei[3],
[1]Master of Arts in Economics, Department of Economics, Moi University, Kenya
[2]Lecturer, Department of Economics, Moi University, Kenya
[3]Lecturer, Department of Marketing and Logistics, Moi University, Kenya

Abstract. Every sovereign nation's goal is to raise the standard of living for its citizens by promoting economic growth. Economic growth is all about increasing productivity which is determined by many macroeconomic variables where energy consumption is a key variable. Kenya uses energy in most of its sectors in order to enhance production. According to Kenya's Vision 2030, Kenya aimed to achieve an average GDP of 10% per annum beginning the year 2012. However, achieving this economic growth rate has been unfeasible. Kenya's economic growth rate has been unimpressive and often fluctuating. The purpose of this study was to analyze influence of gas consumption on economic growth in Kenya. The study period was 2008-2020. Neo Classical growth and Depletion theories were employed. Explanatory research design was employed. Secondary data sourced from the World Bank database. General Method of Moment (GMM) model was adopted. Over identifying test and normality tests were conducted before making inferences. Both descriptive and inferential statistics were carried out. Results were presented in form of graphs and tables. The results indicated that coefficient of gas consumption was -2.1673, p=0.024. This implied that 1% increase in gas consumption would result in a reduction of GDP growth rate by 2.1673%. The study observed that gas consumptions influenced economic growth in Kenya. Government should consider the supply of gas and the nature of subsidy available so that the effect of gas consumption coefficient be reversed in order to have positive effect on economic growth rate. Findings of this study could be utilized by government in budget making process in the parliament or ministerial preliminary budgets and in the allocation of funds to various sectors that require substantial energy input. Additionally, findings could assist the government in order to expand current sources and exploit the other sources of energy such as solar energy, wind energy, thermal energy so as to increase the production and consumption of energy in order to increase economic growth rate. Policy makers could use these findings to establish gas policies that are realistic, time bound and those that enhance sustainable economic growth in Kenya. Finally, academicians could use the results in future references and scholarly studies in creating new angle of thinking and doing things.

Key words: Gas Consumption, Economic Growth, GMM, Kenya

Introduction

Economic growth is the backbone of each and every country. Every sovereign nation's goal is to raise the standard of living for its citizen's by promoting economic growth (Ismaila & Imoughele, 2015). It is a common view that economic growth is all about increasing productivity. The author gave a brief of the US in the analysis of the effect of energy consumption in economy. He pointed out that U.S GDP growth per capita between 1986 and 2011 averaged 2.5%; energy per capita fell by 0.17% a year over the same period. The findings of empirical studies show that there is a strong correlation between electricity use and economic development (Harford, 2013).

According to Liddle (2012) noted that there was an increase in a unit of economic growth brought in by labor and capital efficiency as a result of the issue of energy quality or the use of good-quality energy. Esen and Bayrak (2017) noted in their findings that there was a positive and statistically significant relationship between energy consumption and economic growth

over the long term such that energy consumption contributed more to economic growth as the import dependence of the country decreases. Moreover, the effect of energy consumption on economic growth decreased as the income level of the country increases. This indicated that the efficient use of energy was as important as energy consumption, which was regarded as an important indicator of economic development.

Energy available for consumption, its price, its environmental effects and other externalities and the overall effects of all these on the economy can never be overemphasized as far as economic growth is concerned. This is because all the fore mentioned factors have a strong bearing on energy consumption levels in Kenya which in turn affects the overall economy through influencing the level of productivity which directly will have a bearing on national output and consumption. As Kenya aspires to be a middle-income economy as visualized in Vision 2030, it faces an enormous task of meeting energy needs due to the high expectations in growth to power the economy. The country therefore needs to come up with strategies and investment plans to secure sustainable supply of energy to meet the growing demand. The energy sector is considered to be a key enabler in the achievement of Vision 2030.The major energy consumption sectors in Kenya are commercial sector, transport sector, manufacturing sector and residential sectors. Access to modern forms of energy, even though it's not by itself a panacea to economic development is believed to be pre-requisite for alleviation of poverty, increasing employment and in general, promoting better living standards. While there is no MDG on energy, the access to modern and reliable energy services is an essential input in achieving most of the MDGs, including poverty alleviation, productivity, health, education, communication services and quality governance (Economic Consulting Associates, 2014).

Kenya is among the sub-Saharan African countries that are ranked lowest in per capita energy consumption levels in the world (United Nations Economic Commission of Africa, 2004). In the year 2001, Kenya was ranked number 169 out of 198 in per capita energy consumption worldwide. Energy is a necessity for survival and critical factor affecting economic development in Kenya (NEMA, 2005). About 80 Per cent of Kenya's population relies heavily on traditional energy sources such as biomass, agricultural residues, and other primitive energy sources, which exacerbate environmental degradation and air pollution related health impacts. The United Nations Economic Commission for Africa (UNECA, 2004) has cited the inadequate provision of modern energy services as a limiting factor in Economic growth and poverty alleviation. Energy is regarded as a major enabler in the development of the Kenyan economy. For the country to experience economic growth and better quality life for its citizens, access to adequate and reliable energy supply is imperative. The ultimate goal of the energy sector is to provide the affordable, sustainable and reliable supply of energy that will stimulate high and sustained economic growth leading to higher incomes, increased employment and reduced poverty levels.

Economic growth is a major concern in today's world, especially in developing countries. Economic growth is a necessary condition for economic development which explains why it dominates various government policy thrust documents. High sustainable economic growth improves the quality of living standards but Kenya's economic growth rate has been unimpressive and often fluctuating since independence.

According to World Bank (2015), Kenya's economy in 1964 was at par with that of current economic giants of Asia such as South Korea, Hong Kong Taiwan and other newly industrializing countries. Specifically, in 1965, Kenya's two countries started deviating in 1960s and diverged much widely in the 1990s when Kenya's economy was wrecked owing to macroeconomic instability. Decades later, the East Asian countries GDP per capita is thrice that of Kenya and Kenya's economy continues to be marked by widespread poverty, unemployment and inequalities. Kenya is one the most developed countries in East Africa.

Agriculture is the largest sector of the economy and accounts for about 22 percent. Manufacturing is the second largest sector and represents around 11 percent of the GDP. Kenya needs to multiply its current real GDP growth rate if it's to be able to maintain high standards of living for all its population. The various government regimes have pursued measures and came up with several policy documents to stabilize the economy and propel it towards economic growth. Despite these efforts, real GDP growth in the country continues to be marked with cyclical fluctuations of highs and lows and this calls for investigation to find out why these fluctuations continue to be witnessed.

According to Government of Kenya (2007), energy is one of the foundations of the Economic Pillar of the Vision 2030 that targeted a 10 percent per annum by the year 2012 and thereafter sustained growth by year 2030. Energy is one of the infrastructural enablers of the three "pillars" of Vision 2030. The level and intensity of commercial energy use in a country is a key indicator of the degree of economic growth and development. Kenya is therefore expected to use more energy in the commercial sector on the road to 2030. In the implementation of the Vision 2030 strategies there is need for policy makers and other beneficiaries to clearly understand what proportion of economic growth is attributable to sources-movers of energy consumption. The aim of this study therefore seeks to fill this gap by comprehensively looking at the influence of energy on economic growth. The study will delve more specifically on the influence of gas consumption on economic growth in Kenya. It is therefore critical that various sources-movers of energy be delved with a view of establishing the influence on economic growth in Kenya. This theory as put forward by Roper (1976) governs the reduction of non-renewable resources which includes non-renewable energy resources. According to this theory, depletion is a function of technology and sociology. In the early stage of development, energy resource is relatively readily available but the technology for its extraction and societies need for it is underdeveloped. This means that the consumption of energy is low at the stage. However as the extraction of the resource enters the mainstream of the society its presence generates more need for it and thereby advanced extraction technology. At this stage the rate of energy consumption has increased due to its extended use in the economy. This shows that the production rate at the earliest stages where demand for energy resource is low and the technology applied is underdeveloped; the production rate is an increasing function of the amount already extracted. At the mainstream of the society where extraction use advanced technology, production rate will be a decreasing function of the amount already extracted at that time. At the latest stage when the energy is completely depleted, the production rate will increase at a decreasing rate of extraction at that time. This makes governments to undertake a program known as the optimal depletion program to conserve energy. The study sought to establish the influence gas consumption on economic growth in Kenya.

Research Methodology

A research design is the 'procedures for collecting, analyzing, interpreting and reporting data in research studies' (Creswell & Plano, 2007). The research design sets the procedure on the required data, the methods to be applied to collect and analyze this data, and how all of this is going to answer the research question (Grey, 2014). This study adopted an explanatory research design. Explanatory study sets out to explain and account for the descriptive information. So, while descriptive studies may ask 'what' kinds of questions, explanatory studies seek to ask 'why' and 'how' questions (Grey, 2014). Explanatory research looks for causes and reasons and provides evidence to support or refute an explanation or prediction. It is conducted to discover and report some relationships among different aspects of the phenomenon under study. This design perpetuates the understanding and interpretation of

relationships among the study variables i.e. how energy consumption affects economic growth in Kenya.

This study used the Generalized Method of Moments in analyzing the data. The GMM method produces unbiased, consistent, and efficient estimations. Theoretically stated that the Generalized Method of Moment (GMM) cannot be used when the number of instrumental variables is greater than the number of parameters analyzed. GMM was first formalized by Hansen (1982).

In a method of moments, a population moment condition is that a vector of observed variables, v_t, and unknown parameter vector θ with true value θ_0 which satisfy a $kx1$ element vector of conditions:

$$E\left[f\left(v_t,\theta\right)\right]=0 \text{ for all } t \tag{1}$$

The method of moment estimator θ_T^* is used to solve the analogous sample moment conditions given as:

$$g_T\left(\theta_T^*\right)=T^{-1}\sum f\left(v_t,\theta_T^*\right)=0 \tag{2}$$

Where T is the size of the sample.

Consequently, under the usual regularity conditions, $\theta_T^* \xrightarrow{T} \theta_0$, where θ_0 is the solution for equation 2, in which there are k unknowns and k equations leading to unique solution. Suppose that f is a $qx1$ vector and $q>k$ meaning there are k unknowns and q equations implying that there is no unique solution.

GMM picks a value for θ such that it approaches closest to satisfy equation 2. The closeness can be defined by the following criterion function:

$$Q_T\left(\theta\right)=\left[T^{-1}\sum f\left(v_t,\theta\right)\right]'W_T\left[T^{-1}\sum f\left(v_t,\theta\right)\right]=g_T\left(\theta\right)'W_T g_T\left(\theta\right) \tag{3}$$

Where W_T is the weighting matrix, converges to a positive definite matrix W as T grows large.

The GMM estimator depends on the weight matrix $Q_{GMM}\left(W_T\right)$ which becomes the GMM estimator of θ_0 (true value) given as $\hat{\theta}$ can be obtained by finding argument of the minimum (argmin) of equation 3 as follows:

$$Q_{GMM}\left(W_T\right)=\hat{\theta}=\arg\min Q_T\left(\theta\right) \tag{4}$$

In applying the GMM approach, there are pertinent advantages including the requirement is a moment condition in which there is no need to log-linearize any variable. Further, while non-linearities is not a problem when utilizing GMM approach, GMM is robust to heteroskedasticity and distributional assumptions.

The Generalized Method of Moments (GMM) of estimation of DSGE model was employed in analysis of influence of energy consumption on economic growth in Kenya.

A strength of GMM estimation is that the econometrician can remain completely agnostic as to the distribution of the random variables in the DGP. For identification, the econometrician simply needs at least as many moment conditions from the data as he has parameters to estimate. A moment of the data is broadly defined as any statistic that summarizes the data to some degree. A data moment could be as narrow as an individual observation from the data or as broad as the sample average. GMM estimates the parameters of a model or data generating process to make the model moments as close as possible to the corresponding data moments. Davidson and MacKinnon (2004) indicated the detailed treatment of GMM. The estimation methods of linear least squares, nonlinear least squares, generalized least squares, and instrumental variables estimation are all specific cases of the more general GMM estimation method.

This study was carried out in Kenya. Kenya has an estimated population of 40 million according to the Kenya 2009 census report. A majority of the population are either in the middle class income or low income bracket who are the main consumers of energy products. Kenya's main economic activity is agriculture followed by industrialization.

The research used data that employed yearly data from 2008-2020.The annual data for gas consumption and real GDP were retrieved from the secondary data on energy which was obtained from the World Bank database.

Data analyses were done at descriptive and inferential level. At descriptive level, analysis involved computing descriptive statistics that included means, medians, maximum and minimum values, standard deviations, skewness, and kurtosis. At inferential level, there was the model formulation and estimation. Below are diagnostic tests and estimation of parameters of the study. Diagnostic checks relating to the properties of data to be used in the study modeling need to be implemented in empirical research. In econometric modeling, it is essential to diagnose the following tests for GMM model.

The following equation was investigated:

$$InRGDP_{ijt} = \beta_0 + \beta_1 InGas_{it} + \mu_{it} \quad (5)$$

Where:

β_0 –Constant term

β_{1-} Coefficient of Gas Consumption

Management of quantitative data will involve processing of the data through coding, entering the data into the computer using the STATA 14.

Results and Discussion

Descriptive statistics for the GMM model are reported in Table 1 and include mean, standard deviation and value ranges from a sample of 13 years. The characteristics of the variables which were examined was; gas consumption in relationship to economic growth rate.

Table 1. Summary of Descriptive Statistics

Variable	Observations	Mean	Std. Dev	Minimum	Maximum
GDP Rate	13	4.1075	2.17783	-0.316	8.085
Gas Consumption '000'Tonnes	13	155.755	85.3319	74.6	326.2

Source: Author (2022)

The results in Table 1 showed that the mean value of gas consumption is 155.7538 with a maximum of 326.2 and a minimum of 74.6. The standard deviation of gas consumption is 85.33194.

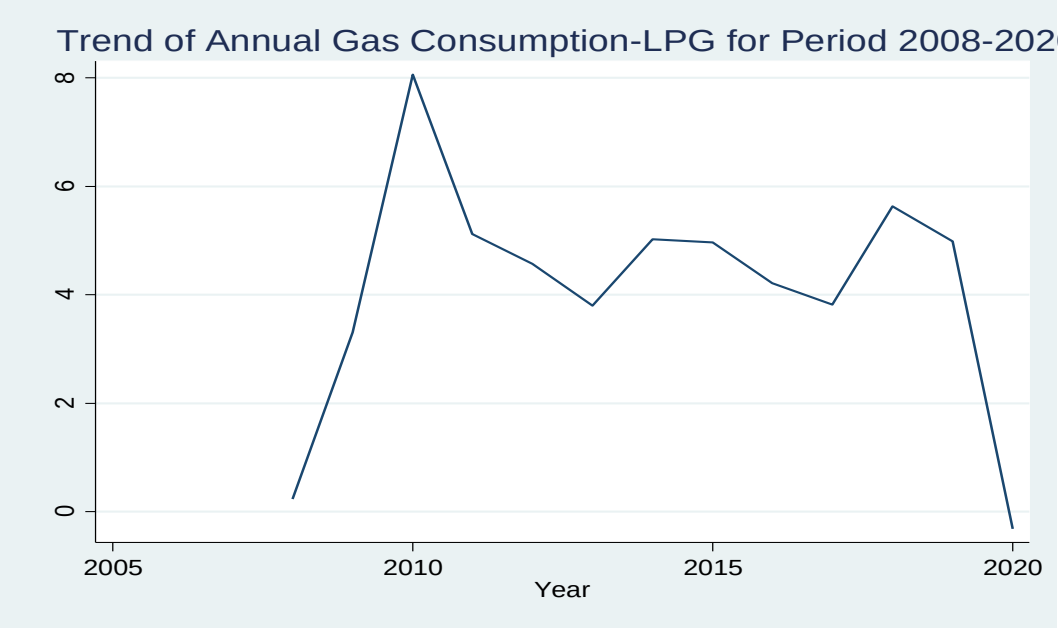

Figure 1. Trend of Annual gas consumption for period 2008-2020
Source: Author (2022)

In Figure 1, it is evident that there has been increase in gas consumption since 2008.Through the years 2010-2019 there has been fluctuations on gas consumption. A substantial drop was seen in the year 2020 on gas consumption from 2019 at 40.40 percent to 4.52 percent.

The results in Table 1 showed that the mean value of GDP is 4.1075 with a maximum of 8.085 and a minimum of -0.316. The standard deviation of gas consumption is 2.177831.

Figure 2. Trend of Annual GDP for period 2008-2020
Source: Author (2022)

In Figure 2, it is evident through the years 2010-2019 there has been fluctuations on GDP rate. In 2010, the GDP rate steadily rose to 8.058. Meanwhile, substantial drop of GDP rate was depicted in the year 2020 on GDP rate to -0.316.

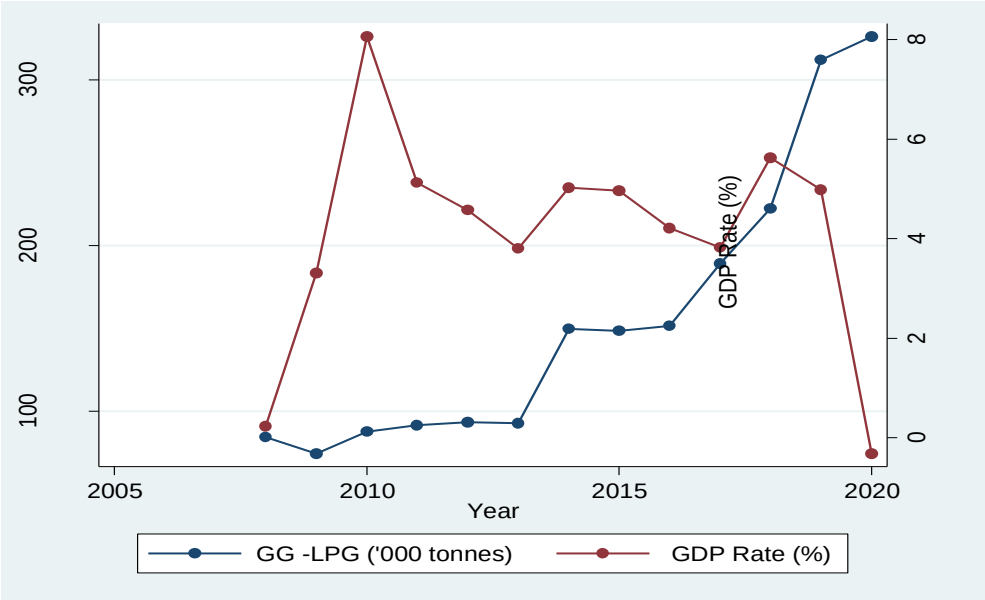

Figure 3. Trend of Annual Gas consumption and GDP for period 2008-2020
Source: Author (2022)

In Figure 3, increase in gas consumption led to an increase in GDP growth rate and vice versa. From 2008 to 2017 there has been rise in gas consumption and thereafter a drop as at 2020 which is equivalent to the GDP rate drop.

The findings of normality test are presented in Table 2.

Table 2. Skewness and Kurtosis Test for Normality

Variable	Obs	Skewness	Kurtosis	Joint
		Coef.	Coef. Z	P>Z
InGDP (Ingdp)	13	0.0030	0.0540 9.75	0.0076
InGas Consumption (*Ingas*) 13 0.3577 0.3662 1.92 0.3834				

Note: *Level of significance at 5%
Source: Author (2022)

The findings indicated that the independent variables did not violate the normality assumption since all individual p-values for skewness and kurtosis for all the variables were greater than 0.05.

Table 3. F-Statistic Results

Source	Sum of Squares	Df Obs.=13 F(3,9)=2.81 P>F=0.1
Model	1.318	0.4395
Residual	1.409	0.1565
Total	2.727	0.2274

Note: *Level of significance at 5%
Source: Author (2022)

F=2.81 P=0.1 meaning the model could be used in the study. R-squared, R2=48.35. This indicated that the variables, that is, loggas explained 48.35 percent of economic growth.

Multicollinearity test results is presented in Table 4.

Table 3. VIF Results

Variable	VIF	Tolerance
Natural Log Gas Consumption	3.23	0.3097
Mean VIF	4.21	0.2375

Source: Author (2022)

The results showed that VIF for natural log of Gas Consumption was 3.23. This showed that the independent variables had VIF less 10 implying that there was no multicollinearity values greater than 10 as supported by (Nachtscheim, 2004).

In addition to the requirement that instrumental variables be correlated with the endogenous regressors, the instruments must also be uncorrelated with the structural error term. The null hypothesis was that there was no over-identification while the alternative hypothesis was that there was over-identification. The result for establishing whether there was over-identification test is presented in Table 5.

Table 4. Results for Establishing Over-Identification Test

Output	Coeff.	Std. Err.	Z	P>|Z|
Natural Log Gas Consumption	-20.8446	9.8943	-2.11	0.035
Overall				0.0470

Note: *Level of significance at 5%

Source: Author (2022)

The results showed that the significance value of p was 0.047 indicating that there was no over-identification in the instruments. This implied that the test of over-identification could be performed. This implied that the model was not over-identified, meaning that the number of additional instruments did not exceed the number of endogenous regressors.

The results for correlation of coefficients is presented in Table 6.

Table 5. Correlations of Variables

	lnGDP	**lnGas**
lnGDP Rate	1	0
lnGas	-0.1152	1

Source: Author (2022)

The results in Table 6 showed that correlation between natural log of GDP growth rate and natural log of gas consumption had a negative value of 0.1152. This showed that the relationship was negative but weak.

The results for the GMM estimation is shown in Table 7.

Table 6. Results of GMM Estimation

	Coefficient	Std. Error	Z Value	P > |Z|
Constant, β_0	-22.0789	8.9434	-2.47	0.014
lnGas, β_3	-2.1673	0.9620	-2.25	0.024

Note: *Level of significance at 5%

Source: Author (2022)

The results in Table 7 showed that the intercept coefficient was negative 22.0789, $P = 0.014 < 0.05$, which significantly determined the GDP growth rate. The intercept is the

parameter in an equation derived from a regression analysis corresponding to the expected value of the response variable when all the explanatory variables are zero (Everitt, 2002). From the above regression equation it was revealed that holding gas consumption to a constant zero; the intercept coefficient was negative meaning the study accounted for most of the determinants of GDP growth rate, that is, gas consumption.

The results in Table 7 showed that the coefficient of gas consumption, β_3, was -2.1673, $p = 0.024 < 0.05$, which was negative and significant at 5% level. This implied that for every increase in one percent of gas consumption, led to a reduction in GDP growth rate of 2.1673 percent. Considering that gas consumption reduced economic growth rate, this meant that the consumers could be utilizing gas in activities which do not increase production. This is true since most of the consumers of the gas could be subsistence which do not increase the production. The government of Kenya could be subsidizing the prices leading to low cost but the usage is subsistence. This means that this leads to reduction of the economic growth in the country.

Sohail *et al.* (2022) mentioned that the outcomes from the nonlinear autoregressive distributed lag model analysis show that in the short-run, positive changes in the natural gas consumption levels increase Pakistan's economic growth. On the other hand, in the long-run, positive and negative changes in natural gas consumption levels increase and decrease the nation's economic growth level, respectively. Furthermore, the Hacker–Hatemi-J causality analysis verifies that natural gas consumption causally influences the economic growth level in Pakistan; thus, verifying the energy consumption-led growth phenomenon. In line with these key findings, several policy level suggestions are put forward for Pakistan to enhance its natural gas consumption level in order to boost its economic growth rate in the future.

Makala and Zongmin (2020) stated that the result of this study indicates that there is no long-run relationship between gas consumption and economic growth. On top of that, causality is only found in Gas consumption to FDI.

According to Seyi and Ada (2018), using the autoregressive distributed lag technique for cointegration, stated that natural gas consumption, both in the short and long-run have no significant impact on output. However, real gross fixed capital formation exhibits positive and statistically significant impact both in the short and long-run on economic growth. By applying the Toda and Yamamoto methodology to test for causality, they found a unidirectional causality running from real gross domestic product (GDP) to natural gas consumption and a unidirectional causality running from real gross fixed capital formation to natural gas consumption. We found non-Granger causality relationships between natural gas consumption and real GDP and between natural gas consumption and real gross fixed capital formation in the long-run. From the empirical results, we infer that, natural gas consumption lacks a role in domestic output as it does not stimulate economic growth, though real gross fixed capital formation does.

Farhani and Rahman (2020) results showed that variables are cointegrated for the long-run relationship. They also indicate that natural gas consumption, exports, capital and labor are the contributing factors to economic growth in France. The causality analysis indicates that feedback hypothesis is validated between gas consumption and economic growth. The bidirectional causality is also found between exports and economic growth, gas consumption and exports and capital and gas consumption.

Conclusions

The observed test statistic, $P = 0.024 < 0.05$ for the coefficient of gas consumption with a coefficient of -2.1673 implying that gas consumption influenced negatively economic growth in Kenya at 5 percent level of significance. Therefore, the null hypothesis relating to gas consumption was rejected at the 5 percent level of significance. Based on the findings, it was

observed that coefficient of gas consumption was negative and statistically significant at 5 percent level. This implied that gas consumption influenced economic growth in Kenya. An increase in gas consumption resulted in a reduction in economic growth in Kenya.

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