SECTORAL ESTIMATION OF THE IMPACT OF ELECTRICITY CONSUMPTION ON REAL OUTPUT IN GHANA

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Abstract

The main aims of this study were to determine the conditions that influence electric power consumption in Ghana and also estimate the extent to which electric power consumption impact on the various sectors of the Ghanaian economy. The ordinary least squares method of data estimation technique was used. The models specified were indentified to be good models. This revealed that the major factors that influence electricity consumption in Ghana are population, the size of the Ghanaian economy, foreign inflows, the general price level, and trade. The study also revealed that electric power consumption affected agricultural production in Ghana negatively and the margin of the decrease was 0.0284186. More so, the study identified that electricity consumption had a positive effect on manufacturing sector of the Ghanaian economy though its value was statistically insignificant. The degree of the elasticity was 0.072129. Finally, the study showed that electric power consumption affected the services output negatively. The degree of the effect was 0.0245882. This study strongly concludes that more electric power supply should be allocated to the manufacturing sector of Ghana to promote sustainable economic growth and development.

Keywords: Sectoral Estimation, Electricity Consumption, Real Output, Ghana

INTRODUCTION

The main aims of this study are to determine the conditions that influence electric power consumption in Ghana and also estimate the extent to which electric power consumption impact on the various key sectors of the Ghanaian economy. Economic growth theorists have identified land, labour, capital, entrepreneur, trade and technology as some major indicators that have helped both developed and developing countries to achieve growth and hence, economic development. Apart from these traditional factors, other factors have been identified by other economic growth researchers to increase economic growth of a country. These other factors

include innovation, economic policies and macroeconomic conditions, government expenditure, financial system, foreign aid, foreign direct investment, institutional frame work, political factors, socio-cultural factors, geography, demography, debt overhang, luck and so on (Enu, 2009). Economic growth economists still continue to identify new factors that are likely to cause and influence economic growth. Electricity consumption happens to be one of the other intermediate inputs identified and considered currently as a determinant of economic growth (Kraft and Kraft, 1978).

Based on general observations and experience, it is known that if there is no electricity supply, then, there is no production, ceteris paribus (Asakereh et al., 2010). Numerous empirical works have examined the causal relationship between electricity consumption and economic growth in some developed and developing economies. Four main findings have been identified. These are; (1) a unidirectional causality from electricity consumption to economic growth (see Akomolafe and Danladi, 2014; Pathan and Abasi, 2014; Shaari et al., 2013; Adhikari and Chen, 2012; Kakar and Khilji, 2011; Orthewere and Henry, 2011; Odhiambo, 2010; Akinlo, 2009; Narayan and Singh, 2007; Altinay and Karagoal, 2005; Wolde-Rufael; 2006), (2) a unidirectional causality from economic growth to electricity consumption (Hossan, 2013; Adhikari and Chen., 2012; Akinwale et al., 2013; Shaari et al., 2012; Ahmad et al., 2012; Kwakwa, 2012; Noor and Siddiqi, 2010; Hye and Riaz, 2008; Binh, 2011; Yoo and Kim, 2006; Kraft and kraft, 1978); (3) bidirectional causality between electricity consumption and economic growth (Akinlo, 2008; Hye and Riaz, 2008; Kaplan et al., 2011; Aktas and Yilmaz, 2008; Chen et al, 2007) and (4) no causality between electricity consumption and economic growth (Ghaderi et al., 2006; Zou and Chau, 2006; Akinlo, 2008).

From the aforementioned, it can be said that about ninety percent (90%) of these studies investigated about the nexus between electricity consumption and economic growth only focus on the causal relationship between total energy (electricity) consumption and total economic growth. In these studies, the total economic growth was not disaggregated into the various key sectors of an economy (agricultural sector, manufacturing sector and the services sector). This means that much research work has been done on the causal relationship between total energy (electricity) consumption and total economic growth. On the other hand, not much research work has been done on the linkage between electricity consumption and economic growth by disaggregating the economic growth into the three main sectors of the economy (agriculture, manufacturing and services), more particularly in Ghana. If this area of research is done elsewhere and in Ghana, it will help identify sectors of the economy that are significantly electricity dependent. This will also help avoid electricity conservation measures that might

affect the growth of these sectors negatively and therefore the overall economic growth of the economy under consideration.

In addition, the impact of other kinds of energy consumption, apart from electricity consumption and their influence on economic growth in some economies have been investigated (Ogunleye and Ayeni, 2012; Aliero and Ibrahim, 2012; Omisakin, 2008). However, not much scientific research in this area has been done in Ghana. Furthermore, the effect of other kinds of energy on the output of the main sectors of the economy is also lacking in the energy and economic growth literature, more particularly in Ghana. Therefore, further investigations need to be carried out in these areas in order to ensure sectoral – purpose driven energy consumption policies in Ghana.

In every economy, an increase in electricity production means an increase in electricity consumption due to the fact that the economic activities are expanding. Ghana is not an exception. The association between electricity production and electricity consumption in Ghana is positive as seen from figure 1 below. The degree of the association is 80%, which is very strong and statistically significant. This implies that as electricity supply continues to increase in Ghana, electricity consumption also increases along side. The reasons could be due to the fact that the Ghanaian population is growing, rural electrification is on the increase, businesses are expanding and so on. The expansion in the economic activities creates other positive externalities such as high levels of employment generation, reduction in cost of living and hence, improvement in the standard of living of the people of Ghana, ceteris paribus. But, are these economic circumstances happening in Ghana currently due to the recent electricity shortages which have led to one-fit-for-all policies of load shedding by the government?

The maximum electricity production level in Ghana is 8.8 billion kWh, while the maximum electricity consumption level is 8.84 billion kWh. This has created an excess electricity consumption of 0.04 billion kWh. In terms of marginal analysis, 100% increase in electricity production in Ghana causes electricity consumption to increase by 82.3%, while 100% increase in electricity consumption causes electricity production to increase by 79%, ceteris paribus. Consequently, this has left a marginal deficit of 3.3% of electricity consumption in Ghana's energy sector. In addition, the net effect of electricity production and consumption has been fluctuating over the years. For instance, in 2001, 2003, 2004 and 2007, electricity consumption in Ghana was in excesses of 0.1, 0.04, 0.04 and 0.61 billion kWh respectively. In the year 2013, electricity consumption was still in excess. These electricity supply shortages have affected the Ghanaian economy negatively. To manage the situation in the short term, this has resulted in one fit for all electricity consumption rationalisation policy which is affecting the Ghanaian economy badly. In view of these serious shortages in electricity supply, the correct

allocation for electricity consumption among the main economic sectors of the Ghanaian economy is very paramount. This will ensure that electricity is used efficiently in and around Ghana.

Figure 1: Electricity Production vs Electricity Consumption, 2000 – 2012 (billion kWh)
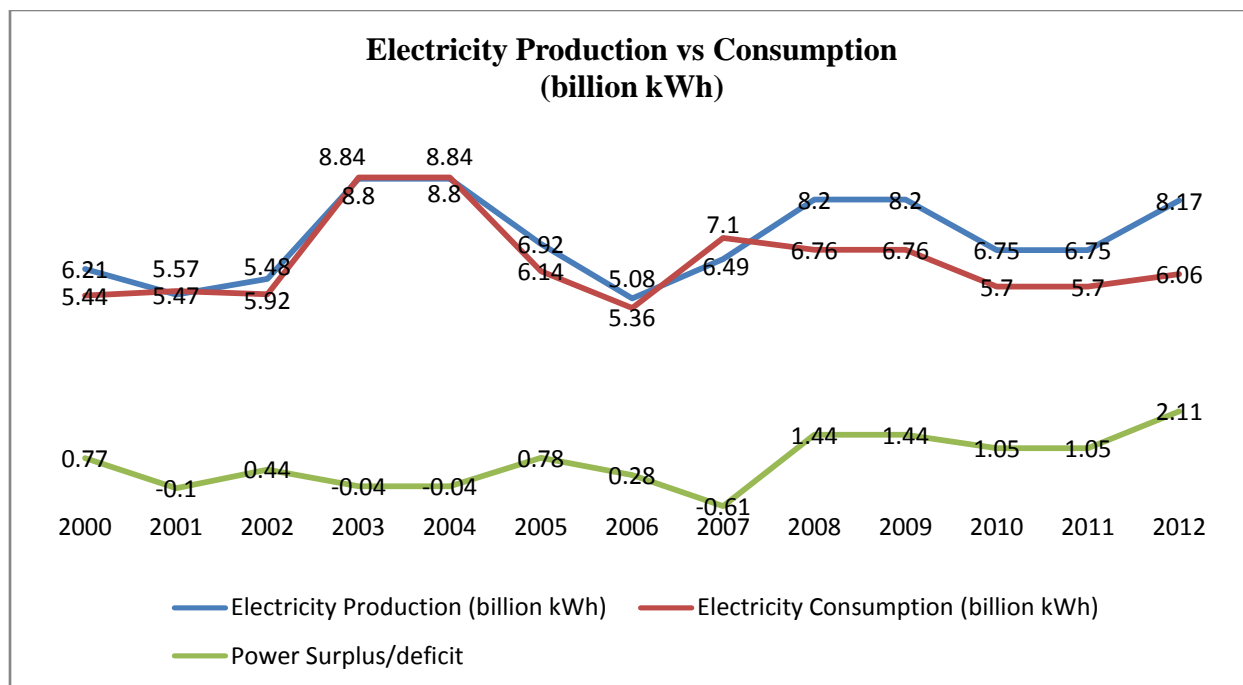
Source: Energy Commission (2013)

From the above analysis, the following questions pop up to be investigated into:

   (1) What factors determine electricity consumption in Ghana?
   (2) To what extent does electricity consumption impact on the three key sectors of the Ghanaian economy (agriculture, industry and services)?

LITERATURE REVIEW

The nexus between electricity consumption and the key sectors of an economy has been investigated. Overall, the focus has been on the causal relationship between the variables, ignoring the extent or the impact to which electricity consumption influences the outputs of these key sectors of the economy. The findings so far are mixed which leaves the conclusion of the debate inconclusive, calling for further investigations in specific countries.

Few studies have investigated the relationship between total energy consumption and sectoral output (Liew et al., 2012; Chebbi and Boujebere, 2008). These studies have helped identify sectors of some economies that are more energy dependent and also helped to avoid

energy conservation policies that might be unhealthy to the growth of these sectors in particular, and the overall economic growth in those economies in general.

Nathan et al. (2013) investigated the effect of primary energy consumption towards disaggregated sectoral outputs of India for the period 1980 – 2009. The results revealed that short-run causality runs from services output towards energy used and energy used towards agriculture outputs. Also, the results showed no evidence of short-run causality effect between energy used and industrial outputs in India.

Liew et al. (2012) determined the interdependent relationship between energy consumption and sectoral outputs in Pakistan. The sectors that were considered were the industrial, services and agriculture sectors of Pakistan. The methods used in the study were unit root test, Johansen-Juselisus cointegration test and Granger causality test. The study found a bi-directional causal relationship between energy consumption and agriculture output. In addition, the study found that services and industrial output separately granger caused energy consumption.

Nwosa and Akinbobola (2012) examined the nexus between aggregate energy consumption and sectoral output in Nigeria for the period 1980 to 2010. The study utilised unit root test, cointegration test and bi-variate Vector Auto-regressive causality test. The study observed a bi-directional causality between aggregate energy consumption and agricultural output while a unidirectional causality was found from service output to aggregate energy consumption. The study concluded that the nexus between energy consumption and output of individual sectors of the Nigerian economy are different and therefore, sector specific energy policies rather than the one fit-for-all policy should be implemented.

Kouakou (2011) investigated the causal relationship between economic growth and electricity consumption in Cote d'Ivoire from 1971 to 2008. The method used was ARDL granger causality test. The study identified bi-directional causality between electricity consumption and GDP. Also, a unidirectional causality from electricity consumption to industry value added in the short-run was identified by the study.

Jamil and Ahmad (2010) examined the relationship between electricity consumption, electricity price and GDP in Pakistan from 1960 to 2008. The study employed Johansen cointegration, and VECM Granger Causality. The study revealed that GDP causes electricity consumption while growth in output in commercial, manufacturing and agricultural sectors tends to increase electricity consumption in Pakistan.

Chebbi and Boujelbene (2008) investigated the cointegration and causality link between energy consumption, agricultural and non-agricultural outputs (manufacturing sector and services sector) and overall gross domestic product in Tunisia for the period 1971 to 2003. The study

employed unit root test, cointegration test, and granger causality test. The study revealed that only unidirectional causality, run from agricultural and non-agricultural sectors to energy consumption as well as from overall GDP growth to energy consumption. They concluded that it is sectoral growth that drives the energy consumption in Tunisia and not the reverse.

Kwakwa (2012) examined the causality between disaggregated energy consumption (electricity and fossil consumption) and overall growth, agricultural and manufacturing growth in Ghana for the period 1971 to 2007. The study used the methods in Augmented Dickey Fuller test, Johansen cointegration test, and granger causality test. The study revealed unidirectional causality from overall growth for electricity and fossil consumption. More so, the study identified unidirectional causality from agriculture to electricity consumption, both in the short and long run. A feedback relationship between manufacturing and electricity consumption was also identified by the study. The study recommended that efforts be geared towards ensuring a high supply of energy to the manufacturing sector of Ghana in order to keep up its contribution to the economy. The literature gaps here are that the industrial sector was ignored as part of the key sector of the Ghanaian economy in this study. Also, the impact or the extent of electricity consumption on the three key sectors of the Ghanaian economy is also ignored. In other words, this study only focused on the causal relationship between the variables of interest.

Therefore, the main goal of this study is to determine the impact or the extent of electricity consumption on the three key sectors of the Ghanaian economy from 1980 to 2013 using the Ordinary Least Squares Estimation technique. This will ensure proper allocation of electricity consumption towards the key sectors of the Ghanaian economy.

METHODOLOGY
Model Specifications
A demand function was specified for electricity consumption in Ghana to identify the key factors that affect electric power consumption in Ghana. The demand function specified was in a log linear form. The reason was that the quantity of electric power demanded was not linearly related to the explanatory variables. The log linear demand model was specified as:

$$\ln ECPC_t = \ln\alpha_0 + \alpha_1 \ln Pop_t + \alpha_2 \ln GDP_t + \alpha_3 \ln FDI_t + \alpha_4 \ln CPI_t + \alpha_5 \ln T_t + u_t ....(1)$$

where;

$ECPC_t$ = electricity consumption measured as electric power consumption (kWh per capita)

Pop_t = population size measured as total population growth

GDP_t = size of the Ghanaian economy measured as gross domestic product in constant 2005 US dollars

FDI_t = foreign direct investment measured as FDI as a percentage of GDP

CPI = general price level measured as consumer price index (inflation)

T = trade measured as exports of goods and services as a percentage of GDP

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ and α_6 are the partial elasticities

U_t = the error term with mean 0.

$\alpha_1 > 0; \ \alpha_2 > 0; \ \alpha_3 > 0; \ \alpha_4 > 0; \ \alpha_5 < 0; \ \alpha_6 > 0$

In addition, the study followed the specification of the Cobb-Douglas production function. The Cobb - Douglas production function in its stochastic form for the various sectors of the Ghanaian economy were specified as follows:

Production function of the agriculture sector

$$AQ_t = \beta_0 L_t^{\beta_1} K_t^{\beta_2} ECPC_t^{\beta_3} e_t^{u_t} ....(2)$$

The log transformation of equation (2) was:

$$\ln AQ = \ln\beta_0 + \beta_1 \ln L_t + \beta_2 \ln K_t + \beta_3 \ln ECPC_t + u_t ......(3)$$

where;

AQ = agriculture output measured as agriculture value added as a percentage of GDP

L = labour input measured as total labour force

K = capital input measured as gross fixed capital formation as a percentage of GDP

ECPC = electricity consumption measured as electric power consumption (kWh per capita)

U_t = stochastic disturbance term

e = base of natural logarithm

$\beta_1, \beta_2,$ and β_3 are partial elasticities with respect to the various inputs

$\beta_1 > 0; \beta_2 > 0 ; \beta_3 > 0$

Production function of the manufacturing sector

$$MQ_t = \delta_0 L_t^{\delta_1} K_t^{\delta_2} ECPC_t^{\delta_3} e_t^{u_t} ....(4)$$

The log transformation of equation (4) was:

$$\ln MQ = \ln\delta_0 + \delta_1 \ln L_t + \delta_2 \ln K_t + \delta_3 \ln ECPC_t + u_t ......(5)$$

where;

MQ = manufacturing output measured as manufacturing value added as a percentage of GDP

L = labour input measured as total labour force

K = capital input measured as gross fixed capital formation as a percentage of GDP

ECPC = electricity consumption measured as electric power consumption (kWh per capita)

U_t = stochastic disturbance term

e = base of natural logarithm

$\delta_1, \delta_2,$ and δ_3 = partial elasticities

$\delta_1 > 0; \delta_2 > 0; \delta_3 > 0$

Production function of the services output

$$SQ_t = \varphi_0 L_t^{\varphi_1} K_t^{\varphi_2} ECPC_t^{\varphi_3} e_t^{u_t} ....(6)$$

The log transformation of equation (6) was:

$$\ln SQ = \ln \varphi_0 + \varphi_1 \ln L_t + \varphi_2 \ln K_t + \varphi_3 \ln ECPC_t + u_t ......(7)$$

where;

SQ = services output measured as services value added as a percentage of GDP

L = labour input measured as total labour force

K = capital input measured as gross fixed capital formation as a percentage of GDP

ECPC = electricity consumption measured as electric power consumption (kWh per capita)

U_t = stochastic disturbance term

e = base of natural logarithm

$\varphi_1, \varphi_2,$ and φ_3 = partial elasticities

$\varphi_1 > 0; \varphi_2 > 0; \varphi_3 > 0$

Method of Estimation

The Ordinary least squares method of estimation was used to determine the values of the respective parameter estimates.

Coefficient of Determination

The coefficient of determination was used to indicate how the explanatory variables included in the models best explain the total variation in the dependent variables. The closer it is to 1 be it positive or negative, the better. The main weakness of the unadjusted R^2 is that it does not take the degrees of freedom into account. This weakness is corrected by using the adjusted R^2 (Mukras, 1993).

The P-Value for Each Explanatory Variable

The p-value for each explanatory variable was used to check whether each coefficient is significantly different from zero or not. Its value should be lower than 0.05. If each explanatory variable of the models has a p-value inferior to the 0.05 critical values, then, it confirms that all the explanatory variables have a significant impact on the dependent variable. To quickly judge whether the models exhibited the problem of multicollinearity, the p – values were used. If the parameter estimates prove to be statistically significant, then, it will mean that the problem of multicollinearity does not exist.

The Global Significance Test

The global significance test was used to test if all the model coefficients were significantly different from zero. If the p-value for the global significance test is lower than the 0.05 critical value, then, it means that all the explanatory variables included in the model have a statistically significant impact on the dependent variable, (that is, the overall multiple regression equation and the parameter estimates are statistically significant and the regression line performs well).

Durbin Watson Statistic (DW) Test

The DW test was used to test for the presence of autocorrelation. The traditional benchmark is 2.0. If DW lies between 1.5 and 2.5, it means that the assumption of linearity is not violated.

Durbin Watson (DW) and R—Squared (R^2)

 According to Granger and Newbold, if the value of the R-squared is greater than the value of the DW ($R^2 >$ DW), then there is a good rule of thumb to suspect that the estimated regression is spurious. The R^2 and the t-statistic from such a spurious regression are misleading, and the t-statistic is not distributed as t distribution and therefore, cannot be used for testing hypotheses about the parameters.

Source of Data and Sample Size

The data used for the estimates were taken from World Development Indicator 2014. The years considered for the data selection were from 1980 to 2012. This gives a sample size of 33 which is greater than the generally acceptable size of 30.

Econometric Package Used

The statistical package used for the estimations was gretl.

RESULTS AND DISCUSSION

WHAT DETERMINES ELECTRICITY CONSUMPTION IN GHANA?

Table 1: OLS estimates using the 31 observations 1981-2011

Dependent variable: lnECPC

Variable	Coefficient	Std. Error	t-statistic	p-value
const	96.0454	36.7104	2.6163	0.01486
lnPop	-7.41176	3.03402	-2.4429	0.02198
lnGDP	1.95853	0.782304	2.5035	0.01919
lnFDI	0.172989	0.0413184	4.1867	0.00031
lnCPI	0.333937	0.23531	1.4191	0.16821
lnT	0.4445	0.136136	3.2651	0.00317

Statistics based on the weighted data: Sum of squared residuals = 66.0057; Standard error of residuals = 1.62488; Unadjusted R^2 = 0.80002; Adjusted R^2 = 0.76003; F-statistic (5, 25) = 20.0026 (p-value < 0.00001); Durbin-Watson statistic = 1.50512; First-order autocorrelation coeff. = 0.339976; Akaike information criterion = 123.403; Schwarz Bayesian criterion = 132.006; Hannan-Quinn criterion = 126.207; Statistics based on the original data: Mean of dependent variable = 22.3216; Standard deviation of dep. var. = 0.42113; Sum of squared residuals = 1.73194; Standard error of residuals = 0.263206

The value of the adjusted R^2 is 76%. This value indicates that approximately 76% of the total variation in electricity consumption is explained by population, gross domestic product, foreign direct investment, inflation and trade. The unexplained variation is 24%. Overall, this multiple regression equation is statistically significant at 5% significance level. Most of the explanatory variables are statistically significant plus the high value of the R^2 which might indicate no problem of multicollinearity. The value of the DW is 1.50512 which is within the acceptable range of no positive or negative autocorrelation. The value of the DW is greater than the value of the R^2 which makes this model spurious free. Therefore, meaningful inferences can be made from this model.

Assuming that no factor affects electricity consumption in Ghana, the amount of electricity that will be consumed will be 96.0454 kWh, all other things being equal.

Population was expected to have a positive impact on electricity consumption in Ghana. Surprisingly, a negative impact was obtained meaning that as population grows, electricity consumption decreases. That is, 1% increase in population growth will cause electricity consumption to decrease by 7. 41176%, ceteris paribus. This value is highly elastic. The reasons could be due to lack of accessibility, affordability and strong energy conservation measures put in place by the government of Ghana. This value, in absolute terms, is statistically significant implying that population growth is a major factor in determining the consumption of electricity in Ghana.

Also, gross domestic product which measures the size of the Ghanaian economy had a positive effect on electricity consumption. This means that as the Ghanaian economy expands, more electricity consumption should be expected. Specifically, 1% increase in GDP will lead to 1.95853% increase in electricity consumption in Ghana, all other things being constant. This value obtained is elastic. This means that a smaller increase in GDP will lead to a greater increase in electricity consumption in Ghana, implying that as business activities expand within the Ghanaian economy, electricity consumption is also expected to increase along side. This value is statistically significant at the 5% significance level indicating that the size of the Ghanaian economy is a key condition is determining electricity consumption in Ghana.

As more highly productive businesses flow from other countries around the world into Ghana to help strengthen the Ghanaian economy, it is expected that the demand for electricity consumption will also increase. This expectation was achieved by this study. 1% increase in FDI will cause electricity consumption to increase by 0.172989%, all other things being the same. This value is inelastic, meaning that a greater increase in FDI will lead to a smaller positive response in electricity consumption. This further means that Ghana as a nation cannot do without FDI and once they come in electricity consumption will increase as well. This parameter is statistically significant at 5% significance level, exhibiting that FDI strongly determines electricity consumption in Ghana.

By the law of demand, the higher the price, the lower the quantity demanded and the lower the price, the higher the quantity demanded, ceteris paribus. This law did not apply in Ghana in terms of demand for power. Rather, an abnormal situation occurred, the higher the price of electricity in Ghana, the higher the quantity demanded of power, all other things being fixed. That is, 1% increase in the price of electricity will cause electricity consumption to increase by 0.333937%. This impact is inelastic, meaning that a higher increase in price will lead to a smaller increase in demand for power, ceteris paribus. This further means that electricity is an ostentatious commodity in Ghana. Ghanaians cannot do without electric power. This value is statistically insignificant at 5% significance level.

Trade liberation also positively affects electricity consumption in Ghana. That is, as Ghana opens her boarders for exports and imports, electricity consumption increases, particularly in the area of exportation. More electricity supply is needed to power plants by local industries in order to produce more goods to feed the domestic economy and some external economies. 1% increase in trade will cause electric power consumption to grow by 0.4445%. This effect is inelastic, meaning that a greater increase in trade will lead to a smaller increase in electricity consumption, ceteris paribus. This parameter estimate is statistically significant at 5% significance level.

Therefore, the major factors that affect electricity consumption in Ghana are population, the size of the Ghanaian economy, foreign inflows, the general price level, and trade.

TO WHAT EXTENT DOES ELECTRICITY CONSUMPTION IMPACT ON THE THREE KEY SECTORS OF THE GHANAIAN ECONOMY (AGRICULTURE, MANUFACTURING AND SERVICES)?

Table 2: OLS estimates using the 32 observations 1982-2013

Dependent variable: lnAQ

Variable	Coefficient	Std. Error	t-statistic	p-value	VIF
const	21.262	5.15778	4.1223	0.00030	
lnL	-1.09353	0.32945	-3.3193	0.00251	3.373
lnK	-0.0424123	0.065765	-0.6449	0.52424	3.705
lnECPC	-0.0284186	0.0584577	-0.4861	0.63065	1.249

Statistics based on the rho-differenced data: Sum of squared residuals = 0.157747; Standard error of residuals = 0.0750587; Unadjusted R^2 = 0.91785; Adjusted R^2 = 0.90905; F-statistic (3, 28) = 4.73963 (p-value = 0.00851); Durbin-Watson statistic = 1.53598; First-order autocorrelation coeff. = 0.214158; Akaike information criterion = -71.188; Schwarz Bayesian criterion = -65.325; Hannan-Quinn criterion = -69.2446

The value of the adjusted R^2 is approximately 91%. This value indicates that approximately 91% of the total variation in agricultural output is explained by labour force, capital and electricity consumption. The unexplained variation is 9%. Based on the values of the Variance Inflation Factor (VIF) for each of the explanatory variables, there is no problem of multicollinearity. The value of the DW is 1.53598 which is within the acceptable range of no positive or negative autocorrelation. The value of the DW is greater than the value of the R^2 which makes this model spurious free. Therefore, meaningful inferences can be made from this model.

Labour as an input was expected to impact positively on agricultural output in Ghana. Unfortunately, a negative effect was realised from the study. This means that as labour force increases, agricultural production decreases in Ghana. This could mean that majority of the labour force found in the agricultural sector of Ghana are not skilled or productive to add to agricultural output significantly. Those trained as agricultural scientists to accelerate or add to agricultural productivity in Ghana find themselves in the other sectors of the Ghanaian economy, more especially in the services sector, maybe, due to the unattractiveness of the agricultural sector and its uncountable problems. Statistically, 1% increase in labour force will lead to 1.09353% decrease in agriculture production. This value is greater than unity, meaning an elastic effect. This value obtained further implies that a greater increase in the Ghanaian

labour force will lead to a proportionate decrease in agriculture output in Ghana, all other things being equal. This parameter estimate is statistically significant at 5% significance level.

Capital, which is a factor of production, was expected to affect agricultural output positively. However, the opposite sign was obtained, indicating that as capital increases, agricultural production decreases in Ghana. This further might mean that most of the agricultural tools acquired by the Ministry of Food and Agriculture did not have human users or even if it was used by farmers, they might have been misused due to the high illiteracy rate among Ghanaian farmers. This idleness of tools, misuse or misapplication of tools has contributed to the negative effect of an increase in capital on agricultural production in Ghana. Statistically, 1% increase in capital will cause agricultural production to decrease by 0.0424123%, ceteris paribus. This value is inelastic, meaning that a greater increase in capital will lead to a smaller decrease in agricultural productivity in Ghana. This value is statistically insignificant at 5% significant level.

Currently, in this modern era where electricity consumption has become a major input in production both in the developed and developing economies, it seems that the agricultural sector of Ghana does not recognise the significant importance of electricity as input to aid agricultural production in Ghana. Why? This is because 1% increase in electricity consumption leads to 0.0284286% decrease in agricultural production, ceteris paribus. This means that farmers in Ghana do not use electricity as a modernised tool to enhance agricultural productivity efficiently and effectively in Ghana, more especially in areas of food cultivation, animal rearing, poultry, harvesting and preservation. They still hold onto the traditional ways of doing things, hence, the negative effect. This value obtained is statistically insignificant.

Conclusively, electricity consumption affects agricultural production in Ghana negatively and the margin of the decrease is 0.0284186%, ceteris paribus.

Table 3: OLS estimates using the 32 observations 1982-2013

Dependent variable: lnMQ

Variable	Coefficient	Std. Error	t-statistic	p-value	VIF
Const	17.6247	5.0626	3.4814	0.00165	
lnL	-1.10776	0.33783	-3.2790	0.00279	3.373
lnK	0.57848	0.127006	4.5547	0.00009	3.705
lnECPC	0.072129	0.119195	0.6051	0.54996	1.249

Statistics based on the rho-differenced data: Sum of squared residuals = 0.596305

Standard error of residuals = 0.145934; Unadjusted R^2 = 0.76078; Adjusted R^2 = 0.73515

F-statistic (3, 28) = 7.25424 (p-value = 0.000952); Durbin-Watson statistic = 1.46534

First-order autocorrelation coeff. = 0.156217; Akaike information criterion = -28.6356

Schwarz Bayesian criterion = -22.7726; Hannan-Quinn criterion = -26.6922

The value of the adjusted R^2 is 74%. This value indicates that approximately 74% of the total variation in manufacturing output is explained by labour force, capital and electricity consumption. The unexplained variation is 26%. Based on the values of the Variance Inflation Factor (VIF) for each of the explanatory variables, there is no problem of multicollinearity. The value of the DW is 1.5 approximately which is within the acceptable range of no positive or negative autocorrelation. The value of the DW is greater than the value of the R^2 which makes this model spurious free. Therefore, meaningful inferences can be made from this model.

The marginal product of labour in the manufacturing sector of Ghana was expected to be positive. However, a negative impact was realised, indicating that as labour force increases, manufacturing output decreases. This implies that Ghana does not have the needed skilled personnel to grow the manufacturing sector which is now the engine of growth. It might also mean that manufacturing in Ghana is not labour intensive. This decline could also result from the fact that Ghana's educational training lacks field work (practicalities) that is supposed to build up the needed labour force and making them ready for the manufacturing sector. Statistically, 1% increase in labour force will lead to 1.10776% decrease in manufacturing production in Ghana, all other things being the same. This value is elastic, meaning that a smaller increase in labour force will lead to a greater decrease in manufacturing productivity in Ghana. This value is statistically significant at 5% significance level.

The partial derivative of manufacturing output with respect to capital was expected to be positive. This positivity sign was obtained by the study. This means that as capital increases, manufacturing production also increases, ceteris paribus. That is, the more man-made tools employed in the manufacturing sector of Ghana, the higher will be its productivity level. 1% increase in capital will cause manufacturing output to increase by 0.57848%, all other things being constant. This value obtained is inelastic, implying that a greater increase in man-made tools will lead to a smaller increase in manufacturing output of Ghana. This value is statistically significant at 5% significance level.

Electricity consumption as an input of the manufacturing sector of Ghana had a positive impact on manufacturing output, though the parameter estimate is statistically insignificant, since the p-value is more than 5%. This shows that as power consumption increases, manufacturing output will also increase, ceteris paribus. Specifically, a 1 % increase in electric power consumption will lead to 0.072129% increase in manufacturing output of the Ghanaian economy. This value is inelastic, indicating that a greater increase in electric power consumption will lead to a smaller increase in manufacturing productivity. Thus, electricity consumption has a positive effect on the manufacturing sector of the Ghanaian economy though it is statistically insignificant. The degree of the elasticity is 0.072129.

Table 4: OLS estimates using the 32 observations 1982-2013

Dependent variable: lnSQ

Variable	Coefficient	Std. Error	t-statistic	p-value	VIF
Const	-8.0472	4.6318	-1.7374	0.09331	
lnL	0.77549	0.29988	2.5860	0.01520	3.373
lnK	-0.170478	0.0773507	-2.2040	0.03592	3.705
lnECPC	-0.0245882	0.0695726	-0.3534	0.72642	1.249

Statistics based on the rho-differenced data: Sum of squared residuals = 0.215481

Standard error of residuals = 0.0877253; Unadjusted R^2 = 0.80177; Adjusted R^2 = 0.78053

F-statistic (3, 28) = 2.91481 (p-value = 0.0517); Durbin-Watson statistic = 1.81735;

First-order autocorrelation coeff. = 0.0783727; Akaike information criterion = -61.2078;

Schwarz Bayesian criterion = -55.3448; Hannan-Quinn criterion = -59.2644

The value of the adjusted R^2 is 78%. This value indicates that approximately 78% of the total variation in services output is explained by labour force, capital and electricity consumption. The unexplained variation is 22%. Based on the values of the Variance Inflation Factor (VIF) for each of the explanatory variables, there is no problem of multicollinearity. The value of the DW is 1.81735 approximately which is within the acceptable range of no positive or negative autocorrelation. The value of the DW is greater than the value of the R^2 which makes this model spurious free. Therefore, meaningful inferences can be made from this model.

The partial differential of the services output with respect to labour is positive. A 1 % increase in labor force will cause the services output to increase by 0.77549%, ceteris paribus. This result implies that as labour force increases in Ghana, services output will also increase. This demonstrates that the Ghanaian labour force in the Ghana labour market is well nurtured for the services sector of the Ghanaian economy. No wonder the services sector is the driving force of the Ghanaian economy currently. This value is inelastic, meaning that a greater increase in labour force will cause a smaller increase in the services output of Ghana. This parameter estimate is statistically significant at 5% significance level.

Theoretically, capital is expected to impact positively on output. This expectation was not achieved. Rather, a negative relationship was found. That is 1% increase in capital leads to 0.170478% decrease in services output, all other things being equal. This could mean that the tools aiding services production are not efficiently utilised. Again, the services sector does not require any intensive use of capital. This value is inelastic, meaning a greater increase in capital leads to a smaller increase in services output. It is statistically significant.

The partial derivative of services output with respect to electricity consumption is -0.0245882. The impact is negative and it is statistically insignificant at 5% significance level.

The degree of the elasticity is 0.0245882. This value is inelastic, indicating that a greater increase in the demand for electric power will cause a smaller decrease in services output. That is a 1 % increase in electricity consumption leads to 0.0245882% decrease in services production, ceteris paribus. The implication is that the unstable nature of electricity supply in Ghana has made electricity consumption very unstable, which affects the services provided by the services sector of the Ghanaian economy negatively.

Thus, electricity consumption affects the services output negatively. The degree of the effect is -0.0245882.

CONCLUSION AND POLICY RECOMMENDATIONS

The main aims of this study were to determine the conditions that influence electric power consumption in Ghana and also estimate the extent to which electric power consumption impact on the various sectors of the Ghanaian economy. The ordinary least squares method of data estimation technique was used. The models specified were identified to be good models.

The study revealed that the major factors that influence electricity consumption in Ghana are population, the size of the Ghanaian economy, foreign inflows, the general price level, and trade. The study also revealed that electric power consumption affected agricultural production in Ghana negatively and the margin of the decrease was 0.0284186. More so, the study identified that electricity consumption had a positive effect on the manufacturing sector of the Ghanaian economy though its value was statistically insignificant. The degree of the elasticity is 0.072129. Finally, the study showed that electric power consumption affected the services output negatively. The degree of the effect was 0.0245882.

Therefore, this study recommends the following policies:

1. More electric power supply should be produced to take care of electric power demand. This can be done by investing massively into the energy sector of the Ghanaian economy by the authorities in charge of affairs to ensure continuous electric power supply to all the sectors of the Ghanaian economy.
2. However, more electric power supply should be allocated to the manufacturing sector of the Ghanaian economy to promote economic growth and development.
3. The agricultural sector of Ghana should maximise her electric power consumption by employing modernised agricultural tools that use electric power efficiently to maximise agricultural production in Ghana. This will safeguard against food insecurity in Ghana.
4. Finally, the residential sector of the Ghanaian economy should subsidize the cost of electric power consumption by the manufacturing sector of Ghana, if possible.

FUTURE RESEARCH

In future, the following will be investigated.

1. To what extent do other kinds of energy affect economic growth in Ghana?

2. To what extent do other kinds of energy impact on the three key sectors of the Ghanaian economy (agriculture, industry and services)?

REFERENCES

Adhikari, D., and Chen, Y. (2012). Energy Consumption and Economic Growth: A Panel Cointegration Analysis for Developing Countries. School of Economics, Dalian University of Technology.

Ahmad, N., Hayat, M.F., Hamad, N., Luqman, M. (2012) Energy Consumption and Economic Growth: Evidence from Pakistan, Australian Journal of Business and Management Research, 2(6), 9-14

Akinlo, A. E. (2009). Electricity consumption and Economic growth in Nigeria: Evidence from Cointegration and Co-feature Analysis. Journal of Policy Modelling, 31, 681 – 693.

Akinwale, Y., Jesuleye, O., and Siyanbola, W. (2013). Empirical Analysis of Causal Relationship between Electricity Consumption and Economic Growth in Nigeria. British Journal of Economics, Management and Trade, 3(3): 277 – 295.

Akomolafe, K.J., and Danladi, J.D. (2014). Electricity Consumption and Economic Growth in Nigeria: A Multivariate Investigation. International Journal of Economics, Finance and Management, 3(1), 28 – 33.

Aktas, C. and Yilmaz, V. (2008). Causal Relationship between Oil Consumption and Economic Growth in Turkey. Kocaeli Universitesi Sosyal Bilimler Enstitusu Dergisi (15)2008/1: 45 -55.

Aliero, H.M., and Ibrahim, S.S. (2012). The Relationship between Energy Consumption and Economic Growth in Nigeria: A Causality Analysis. International Journal of Marketing and Technology, 2(3), 1 -13.

Altinay, G., and Karagol, E. (2005). Electricity Consumption and Economic Growth: Evidence from Turkey. Energy Economics, 27, 849 – 856.

Asakereh, A., Shiekhdavoodi, M.J., and Akram, A. (2010). Investigation of Energy Consumption in Agriculture Sector of Iran and their Effect on Air Pollution and Social Cost. Research Journal of Applied Sciences Engineering and Technology, 2(5), 401 – 406.

Binh, P. T. (2011). Energy Consumption and Economic Growth in Vietnam: Threshold Cointegration and Causality Analysis. International Journal of Energy Economics and Policy, 1(1), 1 – 17.

Chebbi, H.E. and Boujelbene, Y. (2008). Agriculture and Non-Agriculture Outputs and Energy Consumption in Tunisia: Empirical Evidences from Cointegration and Causality, 12th Congress of the European Association of Agriculture Economist – EAAE 2008.

Chen, S. T., Kuo, H. I., and Chen, C. (2007). The Relationship between GDP and Electricity Consumption in 10 Asian Countries. Energy Policy, 35, 2611 – 2621.

Enu, P. (2009). Macroeconomic Determinants of Economic Growth in Ghana (1970 – 2007). Retrieved August 5, 2014 from http://dspace.knust.edu.gh.

Ghaderi, S.F., Azadeh, M.A., and Mohammadzadeh, S. (2006). Relationship between Value Added and Electricity Consumption in the Iranian Industries. Journal of Applied Sciences, 6(2), 387 – 390.

Hossain, MD. S. (2013). Energy Consumption Nexus Economic Growth: A Dynamic Cointegration and Causality Analysis. Scholars World-IRMJCR, vol 1, issue 111, online:ISSN 2320-3145, Print: ISSN 2319-5789.

Hye, Q.M.A., and Riaz, S. (2008). Causality between Energy Consumption and Economic Growth: The Case of Pakistan. The Lahore Journal of Economics, 13(2), 45 – 58.

Jamil, F., and Ahmad, A. (2010). The Relationship between Electricity Consumption, Electricity Price and GDP in Pakistan. Energy Policy, 38, 6016 – 6025.

Kakar, Z.K., and Khilji, B. A. (2011). Energy Consumption and Economic Growth in Pakistan. Journal of International Academic Research, 11(1), 33 – 36.

Kaplan, M., Ozturk, I. and Kalyoncu, H. (2011). Energy Consumption and Economic Growth in Turkey: Cointegration and Causality Analysis. Romanian Journal of Economic Forecasting, 2, 31 – 41.

Koukou (2011). Economic Growth and Electricity Consumption in Cote d'Ivoire: Evidence from Time Series Analysis. Energy Policy, 39, 3638 – 3644.

Kraft, J., and Kraft, A. (1978). On the Relationship between Energy and GNP. Journal of Energy and Development, 3, 401 – 403.

Kwakwa, P.A. (2012). Disaggregated Energy Consumption and Economic Growth in Ghana. International Journal of Energy Economics and Policy, 2 (1), pp. 34 – 40.

Liew, V. K., Nathan, T.M., andWong, W. (2012). Are Sectoral Outputs in Oakistan led by energy consumption? Economic Bulletin, 32(3), 2326 – 2331.

Narayan, P.K. and Singh, B. (2007). The Electricity Consumption and GDP nexus for the Fiji Island. Energy Economics, 29, 1141 -1150.

Nathan, T.M., Liew, V.K., and Al-Mamun, A. (2013). Effect of Primary Energy Consumption towards Disagregated Sectoral Outputs of India. Asian Journal of Research in Business Economics and Management, 3(11), 260 – 268.

Noor, S., and Siddiqi, M.W. (2010). Energy Consumption and Economic Growth in South Asian Countries: A Cointegrated Panel Analysis. International Journal of Human and Social Sciences, vol. 5 (14), 43 – 79.

Nwosa, P. I., and Akinbobola, T.O. (2012). Aggregate Energy Consumption and Sectoral Output in Nigeria. An International Multidisciplinary Journal, Ethiopia, vol. 6(4), serial No. 27, 206 – 215.

Odhiambo, N.M. (2010). Electricity consumption, Labour force participation rate and economic growth in Kenya: An Empirical investigation. Problems and Perspectives in Management, 8(1), 31 – 38.

Ogunleye, E.O., and Ayeni, R.K. (2012). Energy Demand in Nigeria: A Disaggregates Analysis. International Research Journal of Finance and Economies, 86, 52 – 62.

Omisakin, O.A. (2008). Energy Consumption and Economic Growth in Nigeria: A Bounds Testing Cointegration Approach. Journal of Economic Theory, 2(4), 18 – 123.

Orhewere, B., and Henry, M. (2011). Energy Consumption and Economic Growth in Nigeria. JORIND, 9(1), 153 – 165.

Pathan, N., and Abasi, M.A. (2014). Causality between Energy Consumption and Economic Growth in Pakistan. European Journal of Business and Management, 6(4), 46 – 53.

Shaari, M.S., Hussain, N.E., and Ismail, M.S. (2012). Relationship between Energy Consumption and Economic growth: Empirical Evidence for Malaysia. Business Systems Review, 2(1), 17 – 28.

Wolde-Rufael, Y. (2006). Electricity Consumption and Economic Growth: A Time Series Experience for 17 African Countries. Energy Policy, 34, 1106 - 1114.

Yoo, S.H. and Kim, Y. (2006). Electricity Generation and Economic Growth in Indonesia. Energy Policy, 31(14), 2890 – 2899.

Zou, G., and Chau, K. W. (2006). Short and Long-run effects between Oil Consumption and Economic Growth in China. Energy Policy, 34, 3644 – 3655.