International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS), ISSN 2350-1049
Vol. 1, Issue 2, pp: (17-25), Month: July 2014 - September 2014, Available at: www.paperpublications.org

ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN SWAZILAND

Menzi S. Bennett

BA Economics and Statistics

1. INTRODUCTION

The issue of causality between electricity consumption and economic growth (GDP) has been a topic concerning energy economists' for a number of years given that the results have important implications for policy makers. This interest has been stimulated by the persistent increase in the awareness of global warming and climate change. Furthermore, this issue is currently of fundamental importance given the very real threat of global warming and hence the need to cut electricity consumption to reduce emissions to help stem climate change. Renewable energy plays a vital role in economic growth. Energy consumption is, in Africa, one of the mostly consumed capital goods for economic growth realization, and it has nowadays become a need for the society to function properly.

According to the BP Statistical Review (2011), the world population has risen immensely since 1950. In the next 20 years, it is estimated to increase by 1.4 billion. Global energy consumption continues to grow especially in emerging countries such as India and China which are the two most populous countries and are among the top 10 energy consumers in the world. The global population consumes energy for buildings, transportation, agriculture, and industries, and its fast growth significantly increases energy consumption (Batliwala & Reddy, 1993).

Swaziland is no exception since the country's economy is highly dependent on renewable energy consumption. The country currently imports about 80% of its power from South Africa and Mozambique, despite the fact that its renewable energy resources—such as solar, small hydro, wind and residues from the sugar industry—could meet the entire national demand of 200 megawatts if fully exploited. Energy usage is an urgent issue as Swaziland's demand for electricity will continue to rise: access to electricity is currently about 65 percent in urban areas and 45 percent in rural areas. A developed renewable energy sector in Swaziland has the potential to increase these percentages significantly, which would in turn increase energy security, offer environmental benefits and create green jobs, while providing reliable affordable electricity.

According to the USAID report of 2013, the Kingdom of Swaziland has requested USAID's Southern Africa Trade Hub to help develop a Renewable Energy and Independent Power Producer (IPP) Policy as well as a Strategic Environmental Assessment of the policy as an urgent priority. This policy is intended to guide and expand the role of the private sector in developing the country's renewable energy sources and diversify the supply and nature of energy production. The policy will also provide a clear, easily identifiable roadmap for IPPs with a clear delineation of institutional authority and the Kingdom's policy with regard to private power. This will help the country achieve its vision 2020 of achieving the 1st world status and also realize economic growth in the country.

1.1 Problem Statement

Swaziland imports a larger part of its energy from the neighboring countries and as a result electricity prices keep increasing and on the other hand the economy is growing at a decreasing rate. In 2012, Swaziland's economic growth remained one of the lowest in sub-Saharan Africa (SSA), despite a marked increase in the SACU revenues. Although official estimates put real gross domestic product (GDP) growth at 0.2%, it is estimated that the economy marginally contracted by 0.3%, reflecting subdued global recovery, structural bottlenecks and the delayed impact of the fiscal crisis. With population growth at 1.3%, the decline in GDP per capita should have been steeper.

It is reasonable to conclude that one factor explaining poor economic growth is the lack of investments in energy infrastructure and services. ESI-AFRICA, reports that Swaziland is said to have the highest cost of electricity in Southern Africa. Swaziland's tariffs are said to be $11.5 cents per killo watt hour (kWh), which is the highest in the region. On the other hand Swaziland has a lower domestic generation capacity compared to other countries in the region and also a small hydropower plant compared with its counterparts. This is a controversial issue for the country because foreign direct investment is also not improving since 2008. Low investment in energy infrastructure may be an obstacle that may prevent Swaziland from reaching the Millennium Development Goals.

On the other hand, excessive use of renewable energy by industries is tempering with the ozone layer which leads to environmental degradation. However, the depletion in energy consumption can have a detrimental impact on economic growth. According to past studies, energy consumption has a favorable effect on economic growth in many countries (Belke et al., 2011; Francis et al. 2010; Squali, 2006). Even though some studies found that economic has a positive effect on electricity consumption, Altõnay and Karagöl (2004) employ a series of unit root tests and causality tests to verify whether there is causality between GDP and energy consumption for the period 1950 - 2000. Establishing that energy consumption Granger causes GDP has important policy implications, because then a conservation policies will translate into a break on economic growth.

1.2 Objectives

The main objective of the study is to determine the long run relationship and the direction of the causality between economic growth and energy consumption in Swaziland. The study will also make policy recommendations based on the results of the study.

1.3 Hypotheses

This study assumes that there is a positive relationship between energy consumption and economic growth in Swaziland. It also assumes that economic growth has a one way causality relationship with energy consumption. Therefore the following hypotheses are made:
H_0: Electricity consumption granger causes economic growth
H_1: Electricity consumption does not granger causes economic growth
$H_{0:}$ Economic growth granger causes electricity consumption
$H_{1:}$ Economic growth granger does not granger causes electricity consumption

1.4 Justification

The study attempts to find out whether energy consumption stimulates economic growth or economic growth stimulates energy consumption and also the direction of the causality between economic growth and energy consumption in Swaziland. In as much it won't cub the global climate issues, it will provide empirical evidence on the relationship between economic growth and electricity consumption in Swaziland. Policy makers may utilize the results for changes in the energy infrastructure budget by the government as theory does prove that energy consumption has a positive effect on economic growth. Also, this study can be instrumental in the formulation of policies that will prevent negative effects on economic growth.

2. LITERATURE REVIEW

This part of the study deals with a review of existing literature on the causal relationship between electricity consumption and economic growth. This covers both the review of existing theories and empirical findings. A review of existing literature is pertinent in order to ensure proper grasp of subsisting knowledge.
The directions of causal relationship between electricity consumption and economic growth can be categorized under four hypotheses (Jumbe, 2004):

Growth Hypothesis: It implies that causality running from electricity consumption to economic growth. This suggests that electricity consumption plays an important role in economic growth. Any reducing (increasing) in electricity consumption could lead to a fall (rise) in income (Altinay and Karagol, 2005; Shiu and Lam, 2004).

C*onservation Hypothesis:* It is also called unidirectional causality running from economic growth to electricity consumption. This indicates that a country is not dependent on energy for growth and development and then electricity conservation policies will have little or no effect on economic growth. Furthermore, a permanent increase in economic growth may result in a permanent increase in electricity consumption (Ghosh, 2002).

Feedback Hypothesis: It implies that there is two-way (bidirectional) causality between electricity consumption and economic growth. This suggests that electricity consumption and economic growth complement each other (Jumbe, 2004; Yoo, 2006)

N*eutrality Hypothesis*: The neutrality hypothesis is supported by the absence of a causal relationship between electricity consumption and real GDP. This means that neither conservative nor expansive policies in relation to electricity consumption have any effect on economic growth. Thus, it is important to ascertain empirically whether there is a causal link between electricity consumption and economic growth and the way of causality for designing and implementation of its electricity policy implications. The share of major energy resources of the world are 22.5% for coal, 23.9% for natural gas and 37.5% for petroleum (EIA, 2009). Thus, energy prices have allegedly been a significant factor for the economy, especially for the energy importing countries.

The positive relationship between electricity and economic growth has been justified by some Authors as being consistent. Many economists agree that there is a strong correlation between electricity use and economic development. Morimoto R and Hope C (2001) have discovered, using Pearson correlation coefficient, that economic growth and energy consumption in Sri Lanka are highly correlated.

Environmental degradation is the inevitable result of the inexorable increase in energy consumption (Jalil & Mahmud, 2009; Apergis & Payne, 2009). An increase in consumption generates carbon emissions which directly harm the environment. Furthermore, Hameed (2011) stated that more environmental problems occur as the amount of consumed energy increases.

As stated by Fong et al. (2007), environmental problems stunt the economic development planning process if the government does not intervene to reduce energy consumption and carbon emission. Wei et al. (2009) stated that in China, the consumption of coke and coals has undesirable effects on the environment. Therefore, a policy on the reduction of the use of coke, coal, and other low-quality energy is proposed as a solution. Menyah and Rufael (2009) also suggested that South Africa should reduce its energy consumption per unit of output to reduce pollutant emissions.

Whether energy consumption is a stimulus for GDP or not has (as pointed out by, amongst others, Ghali & El-Sakka, 2004 and Wolde-Rufael, 2005) been an ongoing debate among energy economists. On one hand, it is argued that energy is a vital and necessary input along with other factors of production (such as labor and capital). Consequently, energy is a necessary requirement for economic and social development so that energy is potentially a “limiting factor to economic growth” (Ghali & El-Sakka, 2004, p.225). On the other hand, it is argued that since the cost of energy is a very small proportion of GDP, it is unlikely to have a significant impact; hence there is a “neutral impact of energy consumption on economic growth” (Ghali & El-Sakka, 2004, p.225).

The price of energy determines the total consumption. Belke et al. (2011) and Peng and Sun (2010) studied the relationship between energy consumption and real GDP, including energy price, and found that a rise in energy prices has a negative effect on energy consumption. The causality relationship between energy consumption and GDP has been studied extensively over the past three decades, however the evidence still remains controversial, and the energy economics literature has thoroughly examined the nature of causal relationship between energy use and GDP. However, there is no consensus on the direction of the causality; conclusions of these studies are diverged, ranging from unidirectional or bi directional to no directional causality.

The studies in this literature review have no similar conclusion due to different countries, different methodologies and different period covered in different studies. The interest in the subject is dated back to a pioneering study of Kraft and Kraft (1978) which provides evidence to support a unidirectional causality from GNP to energy consumption using the case of USA over the period 1947-1974 by using the Sims Granger methodology. The results obtained indicate that energy conservation might be pursued with no adverse impacts on the economic growth.

Glasure (2002) uses a five-variable vector ECM to study the (Granger) causality between economic growth and energy consumption in South Korea. Government expenditure is used as a substitute for government activity, money supply is used as a substitute for monetary policy and prices of oil are also included as an important factor in explaining the causality. The period 1961 to 1990 is covered in the study. He provides evidence to support a bi-directional causation, and the oil price is found to have the most significant impact on GDP and energy use.

Oh and Lee (2004) also study the relationship between the variables in South Korea, but they covered the period 1970 to1999 in their study. They adopt a system that is more based in the classic production function literature (which is also supported by Stern (1993)). Besides energy, labour and capital are also considered to be important factors of production for generating economic growth. They correct for quality improvements in energy by using a mean price weighted log Divisia index to establish the level of energy consumption in the economy. Following Glasure (2002), they also use a vector ECM and provide evidence to support a bi-directional causation between energy and GDP.

Moroney (1992) argues that energy is a very important factor of production. The oil crises in the 70s and 80s revealed this. The impact of energy on GDP is more than just a minor expenditure of GDP. Stern (1993) in his extensive review of the literature argues that economic growth is not only a product of input factor energy use, but input factors labour and capital also play a crucial role. He argues that the aggregation of labour and energy is difficult. It does not consider the quality differences in labour, which can range from unskilled to skilled jobs. Ideally variables need to be developed to account for these quality differences in labour and energy, for instance, by using wages and energy prices.

Stern (1993) shows that the classic measure of energy consumption does not provide evidence to support causality, while his corrected measure does. He uses annual data over the period 1947- 1990 for the US to confirm this result. In a similar approach Stern (2000) undertakes a co-integration analysis to conclude that energy is a limiting factor for growth, as shocks to energy tend to reduce productivity.

Hondroyiannis et al (2002) study the relationship between energy consumption, GDP and the Consumer Price Index (CPI) for Greece. They consider annual data over the period 1960-1996. They provide evidence to support a long-term bi-directional causality between energy consumption (total and industry) and GDP, while there is no causal relationship between residential use of energy and GDP. This means that demand for residential energy is exogenous and merely neutral to the level of economic growth.

Toman and Jenelkova (2003) argue that most of the literature on energy and economic development discusses how development affects energy use rather than vice versa. This strand of literature considers economic growth as the main driver for energy demand and only advanced economies with a high degree of innovation capacity can decrease energy consumption without reducing economic growth..

Soytas et al (2001) also study the relationship between energy use and economic growth for Turkey, using a multivariate co integration test. They use annual data over the period 1960-1995 from the IEA and transform these data with logarithms. Their results indicate that energy consumption unidirectional Ganger-causes economic output.

Altõnay and Karagöl (2004) employ a series of unit root tests and causality tests to verify whether there is causality between GDP and energy consumption for the period 1950 - 2000. Establishing that energy consumption Granger causes GDP has important policy implications, because then a conservation policies will translate into a break on economic growth. While they show that energy consumption and GDP in Turkey do have a unit root, they also find a structural break in the data. They conclude that there is no causality between energy and GDP.

3. METHODOLOGY

This study analyses the relationship between electricity consumption and economic growth in Swaziland. Economic growth is proxied by real GDP per capita and electricity consumption is proxied by electricity consumption per capita in KWH. Data is collected between 1980- 2010, from the ministry of natural resources in Swaziland, central statistical office and the Central Bank of Swaziland. The study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran and Shin (1999) as well as Pesaran et al. (2001) to analyze both short-run and long-run relationships between electricity consumption and economic growth in the specific context of Swaziland. Therefore, the study expresses the ARDL framework for electricity consumption and economic growth as follows:

$$\Delta \ln(ELEC)_t = \alpha_0 + \sum_{i=0}^{p} \alpha_{1i} \Delta\ln(ELEC)_{t-1} + \sum_{i=0}^{p} \alpha_{2i} \Delta\ln(RGDP)_{t-i} + \alpha_3 \Delta\ln(ELEC)_{t-1} + \alpha_4 \ln(RGDP)_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta\ln(RGDP)_t = \beta_0 + \sum_{i=0}^{p} \beta_{1i} \Delta\ln(RGDP)_{t-i} + \sum_{i=0}^{p} \beta_{2i} \Delta\ln(ELEC)_{t-i} + \beta_3 \ln(RGDP)_{t-1} + \beta_4 \ln(ELEC)_{t-1} + \varepsilon_t \quad (2)$$

Where Δ is the first difference operator, ln (*ELEC*) is the natural log of electricity consumption per capita, ln (*RGDP*) is the natural log of real GDP per capita, p is the lag length, α's and β's are parameters to be estimated, and ε_t is a white-noise error term.

Once the co-integration analysis has been undertaken, the study then investigates the short-run and long-run causal relationships between electricity consumption and economic growth using the method of Granger causality test (Granger, 1969, 1988). This technique is chosen because it performs better than other alternative tests of causality in both small and large samples (see Guilkey and Salemi, 1982). In line with Narayan and Smyth (2006), the test for Granger causality can be done within the following error-correction model:

$$\Delta ln(ELEC_t = \alpha_0 + \sum_{i=0}^{p} \alpha_{1i} \Delta ln(ELEC)_{t-i} + \sum_{i=0}^{p} \alpha_{2i} \Delta ln(RGDP)_{t-i} + \lambda_1 ECT_{t-1} + \varepsilon_t \qquad (3)$$

$$\Delta ln(RGDP)_t = \beta_0 + \sum_{i=0}^{p} \beta_{1i} \Delta ln(RGDP)_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta ln(ELEC)_{t-i} + \lambda_2 ECT_{t-1} + \varepsilon_t \qquad (4)$$

Where ECT_{t-1} is the lagged error-correction term obtained from the long-run equation and the λ's are corresponding adjustment coefficients. If there is co-integration between electricity consumption and economic growth, the significance of the *F*-statistic on explanatory variables will capture the direction of short-run causality, while the long-run causal effect will be determined by the *t*-statistic on the coefficient of the lagged error-correction term. However, if there is no co-integration among the variables, equations (3) and (4) will be estimated without the error-correction term and only the direction of the short-run causality will be determined.

4. DATA ANALYSIS

The study uses annual time-series data for the period 1980 to 2010. The data on real GDP per capita (2000 constant prices) was obtained from the Central Bank of Swaziland, electricity consumption data is obtained from Swaziland Electricity Company (SEC) through the Ministry of Natural Resources. The graphs postulates an upward trend for both real GDP per capita and electricity consumption per capita which shows that both have been inceasing over time. The descriptive statistics of these variables are presented in Table 1. All variables are in per capita form. The entire study uses 31 observations from 1980- 2010 and the mean for electricity consumption per capita is 630.81 kWh and mean for real gross domestic product per capita is E9217.44. The minimum for electricity consumption per capita is 456.93 kWh and the maximum is 853.708 kWh per capita and for real GDP minimum and maximum was E6729.69 and E11138.71 per capita respectively.

For integration between electricity consumption and economic growth in Swaziland, the study uses the Philips Perron unit root test, this method is chosen over Augmented Dickey Fuller test since it is said to adjust for serial correlation and endogeneity of regressors and it allows the possibility of heteroskedastic disturbance terms. Table 2 then reports the presence of unit root when ELEC is the dependent variable and also when RGDP is the dependent variable. The test postulates that at level unit root, we fail to reject the null hypothesis of non-stationerity since the test for both variables the P-values are insignificant and therefore the conclusion is that variables are non-stationery at level unit root. However with unit root at first difference, we reject the null hypothesis of non-stationerity since the p-values are significant 1% significance level hence all variables are stationery. As a result we can conclude that the variables (ELEC and RGDP) are to be integrated of order I (1). This case justifies the use of the ARDL cointegration technique.

The study further examines the existence of long-run relationship between electricity consumption and economic growth using the ARDL bounds testing procedure. The optimal lag length in equations (1) and (2) is selected based on Schwartz Bayesian information criterion (SBIC) and the bounds test results for cointegration are reported in Table 3. If the statistics (F-statistic and Wald [W-statistics]) lie between the bounds, the test is inconclusive. If it is above the upper bound, the null hypothesis of no level effect is rejected. If it is below the lower bound, the null hypothesis of no level cannot be rejected. The results show that when electricity consumption (*ELEC*) is a dependent variable, the null hypothesis of no cointegration is rejected since the calculated *F*-statistic is higher than the upper-bound critical value at 10% significance level. However, when real GDP (*RGDP*) is used as a dependent variable, the computed *F*-statistic falls below the lower-bound critical value at 10% level of significance and hence the null hypothesis of no cointegration cannot be rejected. This implies that there is only one cointegrating relationship between electricity consumption and economic growth in Swaziland.

Since the results imply that there is only one cointergrating relationship between economic growth and electricity consumption, therefore the study will test for the direction of causality using equation (3) and (4) but equation (4) will be estimated without the error correction term since there is no cointergration when ELEC is used as a dependent variable. As a result equation (3) will be estimated with a lagged error correction term to determine the direction of causality.

The short-run causal effect from economic growth to electricity consumption is supported by the statistically significant *F*-statistic at 10% significance level, while the coefficient of the error-correction term, which is negative and statistically significant, provides support for the long-run causality. On the other hand, the reverse short-run causality from electricity consumption to economic growth is rejected by the statistically insignificant *F*-statistic in the economic growth function.

From the hypothesis test, we will only consider the first hypothesis and conclusion is that in Swaziland, RGDP causes electricity consumption hence we fail to reject the null hypothesis.

The long run relationship between RGDP and electricity consumption in Swaziland is supported by the conservation hypothesis in the literature review which specifies that there is a unidirectional causality running from economic growth (RGDP) to electricity consumption. Also on another note Thamae and Sekantsi (2013) found similar results in Lesotho when studying economic growth and electricity consumption in Lesotho. Even though Soytas et al (2001) found that in Turkey, energy consumption Granger causes economic output, other research fellows has

argued that it is mostly common with developed countries that electricity consumption causes economic growth. In China also is the similar case whereby electricity consumption is highly correlated with economic growth due to the high use of technology since they are an industrialized country. Furthermore, Toman and Jenelkova (2003) found that the strand of literature considers economic growth as the main driver for energy demand and only advanced economies with a high degree of innovation capacity can decrease energy consumption without reducing economic growth. This literature review justifies the results being consistent with both empirical and theoretical evidence provided in the literature review.

5. CONCLUSION AND RECOMMENDATIONS

The paper examines the long-run and causal relationship between electricity consumption and economic growth in Swaziland using the ARDL bounds testing procedure for the period 1980 to 2010. We employed the unit root tests, co-integration tests and Granger causality test. Co-integration tests reveal the existence of a long-run relationship between RGDP and ELEC. Causality runs from economic growth to electricity consumption . This results means that electricity consumption in Swaziland is determined by economic growth which means that any policies that are energy conservation policies will not have an effect on economic growth in Swaziland.This is to say, its economic growth that influences electricity consumption not the other way round. This research can be instrumental in the formulation of policies that will prevent negative effects on economic growth.

Since there is no evidence indicating that energy consumption leads economic growth in Swaziland, this means that the energy conservation policies will have little or no impact on economic growth. This is because if an increase in RGDP leads to an increase in electricity consumption, the externality cost of energy use will set back economic growth since there will be more pollution to environment. On another note Swaziland Electricity Company should continue to promote energy efficiency and conservation: This would include education of the public on energy conservation and efficiency. It also involves a review and upgrade of energy efficient standards. This will meet the need for the private sector to utilize more electricity for economic growth purposes. There is also a need to attain efficient pricing of electricity supply: When electricity prices are too high, there is abuse of resource by the masses who can't afford it and this might reduce consumption especially that of the low income class of people. Also, when prices are a bit too low there tends to be inefficient use of electricity.

From the study carried out, it would be a fallacy to conclude that just because the causality runs from economic growth to electricity consumption,this energy sector has no role in economic growth. Electricity consumption is a contributor to economic growth. It is therefore paramount that such a sector is not neglected in the country. Thus, government should ensure that electricity supply is beefed up in diversity so that more economic activity can thrive.

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Appendix - A

GRAPHS FOR BOTH ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH

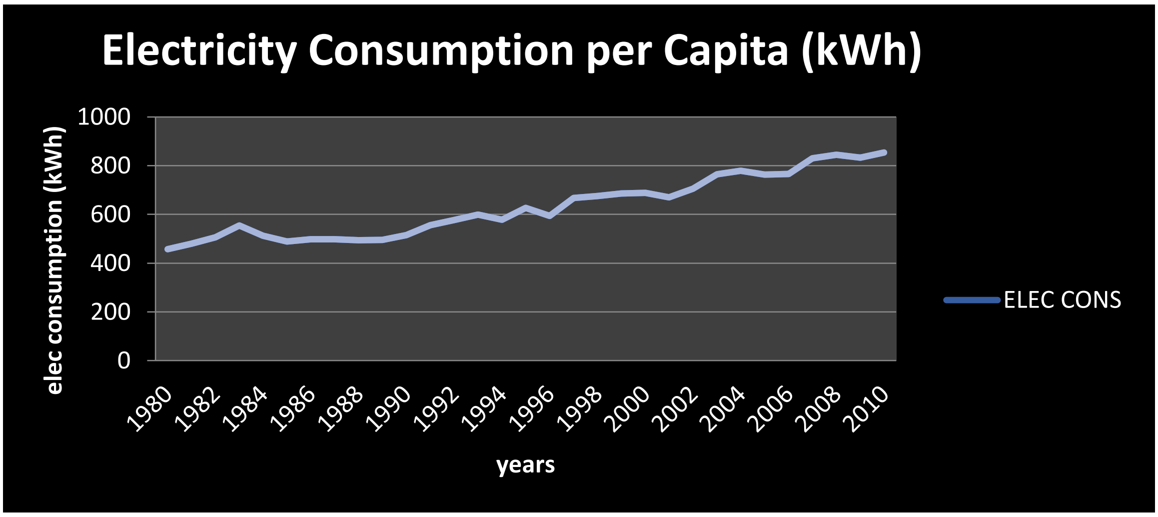

FIGURE 1.1 Trends of electricity consumption per capita 1980-2010

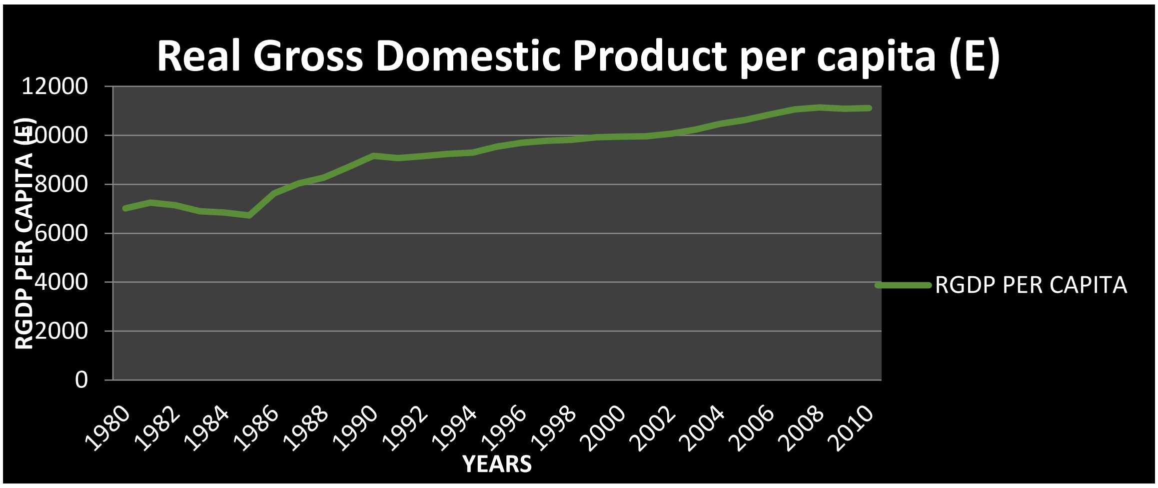

FIGURE 1.2 Trends of real GDP per capita 1980-2011.

International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS), ISSN 2350-1049
Vol. 1, Issue 2, pp: (17-25), Month: July 2014 - September 2014, Available at: www.paperpublications.org

Appendix - B

Table 1: Descriptive Statistics

Variable	Mean	Standard deviation	Maximum	Minimum
Electricity ELEC (kWh)	630.807496885	**125.97**	**853.708**	**456.93**
Real GDP, RGDP (E)	**9217.44710401**	**1414.75**	**11138.707**	**6729.69**

Table 2: Table Phillips-Perron (PP) Unit Root Test

Variables	**Ho: unit root at level**		**Ho: unit root at 1st difference**	
	T-statistics	**P-value**	**T-statistics**	**P-value**
ELEC	-0.09418	0.9256	-6.22117***	0.0000
RGDP	-0.8245	0.4166	-3.2333***	0.003424

*Note: All variables are in logarithmic form and *** indicates significance at 1% level.*

Table 3: Bounds test for cointergration

Model	**Wald-statistic**		**F-statistic**		**Inference**	
F_{ELEC} (ELEC/RGDP)	**6.4814**		**3.2407****		Cointergration	
F_{RGDP} (RGDP/ELEC)	**1.8626**		**0.93132**		No-Cointergration	
Critical value bounds of the F-statistics: intercept and no trend (Narayan, 2005)						
K=1	99%		95%		90%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	5.593	6.333	3.937	4.523	3.210	3.730

*Note K is the number of regressors and ** indicates significance at 10% level.*

Granger Causality with E-views test:

Null Hypothesis:	Obs	F-Statistic	P-value
ELEC does not Granger Cause RGDP	30	0.577	0.454
RGDP does not Granger Cause ELEC		5.56	0.0258***

*Note *** significant at 5% and 10%*

Table 4: Granger Causality Test

Dependent Variable	Causal flow	F-statistic	t-Test on ECT	R-squared
ELEC	***RGDP→ELEC***	**2.5414[0.097]****	**-2.1604[0.040]****	**0.15843**
RGDP	***ELEC→RGDP***	**418.24[0.0]**	----	**0.96873**

Note: The F-statistic and the ECT t-statistics are significant at 10% level.