A Panel Data Analysis on Energy Consumption and its Impact on Economic Growth: Empirical Evidence from Twenty Developing Economies.

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ABSTRACT

This study examines the panel granger causality test between total primary energy consumption per capita and Economic growth. The long run and short run relationship was also tested by adopting the Pedroni Residual Co-integration test which suggested no co-integration. Meaning, there is no long run relationship between the two variables. This test was done using annual data from 1992-2011 for twenty 20 developing economies around the world. All evidence gathered from this empirical analysis was through the application of this tests-Pedroni residual co-integration test, Phillip-Peron (PP) test, Augmented Dickey-Fuller (ADF) test, Stacked (common coefficient) causality test, Dumitrescu-Hurlin (Heterogeneity or unequal) Panel causality test and the Heterogeneous Panel VAR test. The final results obtained showed that no causality was found between the two variables. However, further testing for shocks using the heterogeneous Panel VAR test revealed a short run relationship running from primary energy consumption to economic growth for the countries mentioned. The study therefore recommends government policies towards energy development and effective policies towards shocks in the short run without neglecting its effect in the long run.

Keywords: Primary Energy consumption, Economic growth, Causality, Panel VAR.

ÖZ

Bu çalışma aynı zamanda hiçbir ko-entegrasyon önerdi Pedroni Artık Co-entegrasyon testi benimseyerek test edilmiştir toplam birincil kişi başına enerji tüketimi ve Ekonomik growth.The uzun vadede ve kısa vadede ilişkisi arasındaki Panel nedensellik testi inceler. Anlamı, iki değişken arasında uzun dönemli bir ilişki vardır. Bu test dünyada yirmi 20 gelişmekte olan ekonomiler için 1992-2011 yıllık veriler kullanılarak yapıldı. Bu ampirik analiz toplanan tüm deliller, Phillip-Peron (PP) testi, Genişletilmiş Dickey-Fuller (ADF) testi, Yığın (ortak katsayısı) nedensellik testi, Dumitrescu-Hurlin bu testler-Pedroni artık eş-bütünleşme testi uygulaması ile oldu (Heterojenite veya eşitsiz) Panel nedensellik testi ve Heterojen Paneli VAR testi. Elde edilen nihai sonuçlar thatno nedensellik iki variables.However arasında bulunmuştur gösterdi, heterojen Panel VAR testi kullanılarak şoklar daha fazla test söz konusu ülkeler için ekonomik büyüme birincil enerji tüketimi çalışan bir kısa çalışma ilişkisi saptandı. çalışma bu nedenle, uzun vadede etkisini ihmal etmeden enerji gelişimi ve kısa vadede şoklara karşı etkili politikalar yönelik hükümet politikaları önerir.

Anahtar Kelimeler: Primary Energy tüketimi, Ekonomik büyüme, Nedensellik, Panel VAR.

DEDICATION

I dedicate this work to God and to my wonderful family for seeing me through my study period.

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LIST OF ABBREVIATIONS

TECK	Total Energy Consumption Per Capita
GDPK	Gross Domestic Product Per Capita
OPEC	Organization of Petroleum Exporting Countries
OECD	Organization of Economic Co-operation and Development
IEA	International Energy Administration
WDI	World Development Indicator
ADF	Augmented Dickey-Fuller
PP	Phillip-Perron

Chapter 1

INTRODUCTION

1.1 Background to the Study

The level of primary energy consumption is a very significant factor in determining efficient economic growth of a country. The use of energy serves as the center of all human activities for both developed and developing countries. Energy consumption has always been the most vital requirement of human societies and its demand has grown far greater than ever in the past decade. It is referred to as one the major factor for any sustainable economic growth and development, and acts as a key instrument in creating transnational mediation for different economies and aids in tradable product which provide a means of generating revenue used to finance government spending and growth programs.

In the past decades it has served two purposes. Firstly, as a means for economic growth and secondly, as a means for generating revenue specifically for energy producing countries (i.e. OPEC). It relatively constitutes a large share of GDP in most countries especially developing countries. Thus it is described with no doubt as the engine that drives the nation.

Energy use as a vital factor of production that is used up during production and consumption process, the relationship between primary energy consumption and economic growth has become a focus of countless analysis as energy use is referred to as one of the essential motivating influence of growth and development in all economies.

World economies are heavily reliant on energy specially developing nations. One of the basic importance of energy as mentioned is its extracting, transforming and distribution of goods and service. It also impact on the economy by creating jobs. For instance in 2009, the United States of America, the energy sector has accounted for about 4% of its total GDP. While in other developing countries that rely heavily on energy, its share are higher on total GDP; it holds 30% of Nigeria's GDP, 37% in Venezuela and 57% in Kuwait (world economic forum, 2012).

The slowdown in global financial crisis has particularly been the driving force of oil price. From 2001 to 2008, despite the persistent slow down and instability in the global economy, oil prices has subsequently multiplied. Regardless of the very sluggish recovery in the industrialized economies, evolving markets have enjoyed more of a progressive recovery. Rapidly growing economies like China, India, the Middle East (basically Asia) other oil producing economies, have shown continuously demand for energy and these has significantly substituted for the lost growth from the developed economies. (Kenneth Rogoff, 2012).

In 2010, according to Zhang Guobao (2012), the level of Energy demand in emerging economies has performed a leading role in the total growth rate in global energy demand. Primary energy consumption in non-OECD countries went up by 7.5% while energy usage in the OECD countries rose by 3.5%, which is no different from the growth rate decades ago. While Developing countries like Brazil, Russia, India and China, have continued to experience rapid increase in total energy demand.

1.2 Statement of the Research Problem

In developing countries, increasing economic growth is a pathway for better opportunity to become more industrialized.

Some of the basic factors that are commonly acknowledged as the paramount indicator for any economic growth or level of development, the wealth and industrial potency of an economy, is the amount of energy that is accessible and used-up by that economy. The reason for this is because; the level of primary energy consumption and economic growth has shown the existence of a strong statistical correlation. This relationship is established due to the dependence of the many economic activities on the availability of energy.

From the above it has become important to discuss certain issues regarding the relationship between primary energy consumption and economic growth. The following question arises:

I. To what extent has the consumption of energy contributed to the country?

II. To What direction is the causal link between the two variables?

III. What policy and investment decisions so far adopted to boost energy consumption in the countries?

1.3 Objectives of the Study

The main objectives of this research are to examine the contribution of total primary energy consumption per capita and its impact on economic growth for Twenty (20) developing countries. While the specific objective I attempt to investigate are as follows;

I. To analyze the link between total primary energy consumption per capita and GDP per capita.

II. To analyze the structure and trends of primary energy consumption in developed and developing countries as well as the world as a whole.

III. To evaluate energy promotional policies.

To make recommendations that help formulate proper policies for energy production and consumption in host countries.

1.4 Significance of this Study

The causal link between primary energy use and growth is constantly a demanding debatable subject in the history of the study of energy economics. As argued by some energy economists that energy resources is an essential input in the production process alongside with other factors inputs of production such as capital and labor. However, some have also argued that the impact of primary energy consumption is only but a small fraction of GDP, therefore having a generous effect on economic growth is unlikely.

Therefore, it becomes important to test the direction of a causal relationship between the primary energy use and economic growth and also to determine whether primary energy use is a major determining factor or contributing factor of economic growth or vice versa?

1.5 Research Methodology and Hypothesis

In This study, I will be using the annual Secondary data covering the year 1992-2011 for twenty developing countries. The Secondary data for total primary energy consumption per capita and GDP per capita will be collected from International Energy Administration (IEA, 2014), Index Mundi, BP Statistics (2013), and the World Development Indicator WDI (2014). Using the statistics gotten from the mentioned sources, I will be adopting the two granger causality tests to provide evidence on the direction of causality for the named countries. This model will consist of the two variables which I have chosen to explain the correlation between GDP and energy (TEC).

The following hypothesis will be tested;

H_0:that, energy consumption per capita does not granger cause economic growth.

H_1: that, energy consumption per capita granger cause economic growth.

1.6 Organization of the Study

This research work is divided into 6 chapters.

Chapter 1, which is the introductory section, includes the statement of the study, significance of the study, objective and work organization. Chapter 2 and 3covers the theoretical and the empirical literature review. Chapter 4 focuses on the trend in energy consumption and economic situation in the world. While the empirical specification of data and the estimation of techniques as well as the interpretation of result is illustrated in chapter 5. Finally, chapter 6, will be the conclusion and recommendation offered.

Chapter 2

THEORITICAL LITERATURE REVIEW

2.1 Introduction

In the study of economics, production is a very important theory that cannot be ignored. The initial production process involve the use of the basic factors of production which are referred to as inputs, and are used up at the initial level of production, while inputs that are created during the production process are referred to as intermediate inputs and are used up entirely in the economic production process. Various Economists have referred to capital, labor, and land as the primary factors of production, while goods such fuels and other raw materials are referred to as intermediate inputs. This concept has led to an empirical issue in the growth theory as to what are the basic primary factors (inputs) of production, particularly, the position of energy use in production process. (Stern, 1999).

This chapter reviews economic growth models that reveal the role of energy in the production process and the linkages connecting energy resources and economic growth.

2.2 Theory of Production and Growth Model

2.2.1 Solow Growth Model

The role of energy use can be shown under the framework of a standard Solow growth theory which is referred to as the Basic Growth Model of Economic (1956).

It is one of the growth theories which have been in use for decades. The Solow growth model is also called the exogenous growth model because it refers to technology as an exogenous factor in the production process which contributes to economic growth. However, to include energy resources into the production process we assume that a reasonable amount of energy is infused into technology which is used up during the production process. Of cause we know that no technology usage can be performed without a useful involvement of energy resources. For example, the use of some plants, machines and computers in a production process will require available amount of electricity, fuel, gasoline, diesels etc. Some of the assumptions of the Solow growth model are:

I. labor and capital has diminishing returns

II. output increase at a decreasing rate

III. Constant returns to scale – output doubles only when inputs are doubled.

And a constant amount of the output is saved and invested while a constant amount of capital stock is depreciated. The relationship between energy use and economic growth can be illustrated by the use of a common production function which is the Cobb-Douglas production function. Output is produced based on

$Y_t = AK_t^{\alpha}L_t^{\beta}$……………………………………………..............…………. (1)

Where, Y is the aggregate output at time t, A represent exogenous technology, L and K represents labor and physical capital while α and β measures the elasticity of output with respect to labor and capital.

Nevertheless, the significance of the Solow growth model is the fact that it clarifies the impact of a long run growth in income by the rate of exogenous technological progress. This can be explained by the total factor productivity with the use of the Solow residual. It measures the effect of technological change on the level of output.

$\frac{\Delta A}{A}$ = gA…………………………………………………………....……........(2)

ΔK = sK- δk…………………………………………….………......................... (3)

Total factor productivity indicator (Solow residual);

$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - \alpha \frac{\Delta K}{K}$ - (1-α) $\frac{\Delta L}{L}$ ………………………………………………….................(4)

2.2.2 New Growth Model

The New Growth model also referred to as The Romar Endogenous Growth model developed in 1986, was said to come about as a response to the errors of the basic growth model (exogenous) by Solow. He criticized the model by saying that the model did not explain how the improvement in technology came about but it just happened exogenously. In his theory his target was to examine economic growth in the long run by taking technical progress and knowledge as endogenous product and including them as input in the production function. The basic assumptions of his model are:

I. Increasing returns to scale are due to increasing externalities,

II. Labor and advanced technologies are vital for long run growth.

III. Investing in Research and Development is key for technological advancement

IV. Knowledge and technical advancement are non-competitive good.

This model professes that as long as new ideas, innovation and technological advancement are constantly available; it serves as prerequisite for the economy to grow faster for a long period of time. He also states that a greater level of savings and capital accumulation be allocated for increased investment in human capital, Research, and development.

Similar to Solow (exogenous) growth model, the Romar (endogenous) growth model also suggest that for the convergence process of poorer countries to meet up with the richer world by gradual imitation, technology is a necessary characteristics in the production process. The production function of a firm is shown below;

Y=F (A, Ri, Ki, Li)………………………………………………..........……..... (1)

Where: A technology, i is the firm, Ri represents expenditure on research and development (technology advancement), Ki represents Capital of the firm, and Li represent labor of the firm.

Thus, in the endogenous growth model research in technology is vital in the production process for any rational profit seeking firm and is used as an endogenous factor by acquiring innovative knowledge. Technology here refers to the use of plants, machinery, computers, and without adequate energy use (in this case electricity or petroleum) then the use of technology will meaningless.

2.3 Properties of Energy Resources and Commodities

Energy resources or commodities are resources that take different physical forms. These forms may include chemical energy, mechanical energy, thermal energy, radiation, electrical energy (electricity), or the potential to create energy through nuclear reactions. These physical forms of energy resources may be converted to take different forms like; oil, natural gas, biomass, electricity, infrared radiation, water fall, wind energy, and uranium etc.

David I. Stern (2004) as professed in his book “Economic Growth and Energy” suggests the conversion process of energy is very important to the production process and human experience. Fire provides heat and light (radiant energy).

2.4 Link between Energy Consumption and Economic Growth

Trend in energy consumption in the developed and developing economies has been a topic of debate, which I will discuss in the next chapter. Using the US economy for example, the level of energy consumption has hardly changed since the period 1970s to 1990s, regardless of the increasing GDP. The reasons for the break in the trend have been the topic of argument.

To examine those factors we can use the neoclassical production function to determine the strength and weakness in the linkage between energy use and economic activity. It is represented as:

$Yi= F(A, K_i, L_i, E_i)$………………………………………………………............ (1)

Where; Yi represent outputs manufactured goods and services), the Ki and L_i is capital and labor inputs, the E_i represent various energy inputs, and A is the state of technology. Some other factors that can affect the link between energy usage and the level of output are:

I. Substituting energy resources and other factor inputs
II. Technological advancement
III. Changes in the combination of the energy input.

2.5 Energy Substitution and Capital

David Stern (2004) tries to observe the relationship between capital and energy resources as to if they are complements or substitutes factors of production. In his book “Economic Growth and Energy”, he stated that capital and energy resources act like substitute factors (long run) and supplement (short run) and although they are gross substitutes, they are net supplement. No studies on the degree at which capital and energy resources act as substituted are available. Although there are a few empirical analyses on energy substitution issues, there results vary.

2.6 Energy Efficiency and Innovation

Based on the Schurz hypothesis (1999), it states that capital equipment that permits the use of Innovative energy resources such as electricity encourages more proficient and productive outcome. Assuming other prices is held constant; the share of expenditures assigned to the amount of energy resources that are used up during production tends to increase over the period. He concluded that in that case, if energy resource prices are low, then the Total Factor Productivity growth will accelerate or otherwise. (David Stern, 2002).

2.7 Changes in the Composition of Energy Inputs

The quality of energy is also important in the production process. Also in David I. Stern (2004) book “economic growth and energy”, he argues that the quality of energy can be referred to as the relative economic usefulness per heat equivalent unit of different fuels and electricity. He suggested that we can measure this quality by the raise in the amount of products produced using one additional heat unit of fuel which will give us the marginal product of the fuel. Such services may consist of services gotten directly from energy consumed by consumers. Fuels can be used for various kinds of activities or for more important activities. For example coal cannot be used to power a printing machine but electricity can be used. Therefore, the marginal product of fuel is determined by the qualities distinctive to the amount of fuel stored, ability to be productive, energy compactness, flexible to store, security, elasticity of utilize, and how much to spend on conversion etc. (David I. Stern,2004)

Among the leading researchers to identify the economic significance of energy quality were Schurz and Netschert (1960). They Stated that the structure to which energy is been use have changed considerably over the time.

Chapter 3

EMPIRICAL LITERATURE REVIEW

3.1 Introduction

The causal relationship between primary energy use and economic growth has been a constant controversial issue in the literature of energy economics due to diversity in empirical studies. So many energy economists have argued that energy is a vital input to any production process for development and growth alongside with other factors of production, and as such, increase in energy consumption will lead to economic growth. Hence, energy is an essential requirement for economic growth and theoretically a facilitator for economic and social development for any economy particularly developing countries. (Sarwat Razzaqi, 2011)

Nevertheless, other energy economists have provided empirical evidence economic growth rate is not influenced by the level of energy use, instead they suggest that the level of international development of a country is what influences energy demand (Christian Dragger).

It is then necessary to re-examine the short-run and long-run relationship between primary energy consumption and economic growth or to identify if primary energy consumption is an important cause of economic growth by checking the correlation and direction of causality. If the direction of causality is from energy consumption to GDP, then we can conclude that energy consumption is important to such economies and any limitation can have severe effects on the speed rate and level of development in the economies.

Looking at the complexity and significance of this research, several endeavors have been prepared by various researchers and authorities to verify the long-run and short-run relationship between primary energy consumption and economic growth as well as the direction of causality for different countries.

3.2 Energy use and Economic Growth: Empirical Studies

Empirical studies to examine the casual direction and relationship between energy consumption and economic growth has been carried out by Various researchers Among which are Valeria Costantini and Chiara Martini(2009) who collectively organized economic data from 1960-2005 for 71 countries. These authors grouped the countries into two parts, non-OECD (with 26 countries that are relatively homogenous) and OECD (with 45 countries that are classified as heterogeneous). In their study, to examine the causal link energy and economic growth using a non-stationary co-integrated panel data, The outcome of their study shows that the focus of the causal relationship remains unchanging (uni-directional, energy consumption→ GDP) for the non-OECD countries in the long-run, which indicate that energy consumption is strongly affected by economic, particularly the industrial sector demand. In contrast, the OECD countries show an opposite direction of causality in the long run (GDP→ energy). These can be explained by the energy conversion action use by so many developing countries after the first oil crisis which mainly relate to the industrial sector.

In Sarwat Razzaqi and Saadia Sherbaz study, by adopting the VAR Granger Causality for the period 1980-2007, in the D8 countries (developing economies) namely, Iran, Bangladesh, Egypt, Indonesia, Malaysia, Nigeria, Pakistan and Turkey. Evidence gathered from this study shows both uni-directional (energy consumption→ GDP) and bi-directional (GDP↔ energy consumption) causality in the long-run and in the short-run for all the countries with the exception of Indonesia where no causality was founding the short run between the two variables. They concluded that energy sector development policy should be adopted by these countries based on priority.

Testing the direction of causality between primary energy consumption and economic growth by Soytas and Sari in 2003 for leading ten developed economies and the G-7 countries, a bi-directional causality was establish for Argentina while countries like Japan, Germany, turkey, Korea, Italy And France had a uni-directional causality (energy→ GDP).In 2001, they also tried to investigate the relationship between primary energy consumption and GDP for Turkey for the period 1960- 1995. The outcome shows that a unidirectional relationship (energy →GDP) for the period was. Same test on electricity use and growth was investigated in Pakistan (2001) which is described as a country like Nigeria were electricity is a basic problem. Ageel and Mohammad after running a co-integration test found that increase in the consumption of electricity will lead to economic growth.

According to Evan Lau, Xiao-Huichye, Chee-Keong. C (2011) study, using panel estimation for seventeen (17) Asian countries, from 1980 to 2006, they empirically tested the relationship between energy consumption and economic growth. Their result shows a long-run equilibrium relationship among the two variables. They observed a short-run unidirectional causal relationship running from energy consumption to GDP using the Granger causality test. Given that these Asian economies are energy dependent, in the short-run increase in energy consumption will lead to economic growth. While in the long run, the estimated results indicated that an increase in GDP would lead to a greater use of energy.

Using a bootstrap panel analysis on causality for a sample of sixteen (16) heterogeneous African countries over the period 1988-2010, Mohamed El H Arouri, Adel B. Youssef, Hatem M'Henni, Christophe Rault (2014) findings was discussed in four sections. The first section showed that Energy use positively causes GDP growth in Egypt, DRC, Kenya, Morocco, Senegal, Tanzania and Tunisia. This positive impact suggests that an increase in energy use increases GDP. Economic growth is linked to the use and consumption of energy in those countries and they are expanding the electricity coverage and electrification which allows better opportunities for work, for training and varieties of economic activities.

Also in 2012, Mohamed El H.A, Adel Ben, Youssef H. M'henniand Christophe Rault, conduct a test to examine the link between energy consumption, CO_2 emissions, and economic growth from 1981-2005 for MENA countries namely; Tunisia, Algeria, Oman, Qatar, Saudi Arabia, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, and UAE (homogenous countries with about 60% of the world's oil reserves.). Using the non-stationary panel data econometrics, estimates indicated that in the long-run energy impact GDP andCO2 emissions positively in the region. More importantly there was correlation between real GDP with CO2 emissions.

On the other hand, Mohammed Issa Shahateet (2014) testing for causality in 17 Arab Countries from 1980 to 2011. Their estimates indicated no causality running from energy consumption to real GDP in all the Arab countries (except Kuwait). These Empirical results confirm neutral stances were the link between energy consumption and economic growth is insignificant for these countries. This implies that strategies targeting at energy preservation in these countries do not restrict economic growth and, in future any shocks to energy supply will have no effect on economic growth. But fluctuations in economic growth are likely to have significant impact on the level of energy consumption.

In June 2006 J. Chontanawat, Lester C. Hunt, and Richard Pierse adopted three different methodologies to test the Causal link between Energy Consumption and GDP by looking at 30 OECD and 78 Non-OECD Countries. They adopted the conventional methodologies, co-integration and the Error Correction Model from the year 1947 to 2002.Theirestimatespecified that direction of causality runs with about 57% from GDP to energy in the OECD countries, while only 47% for non-OECD countries. This analysis offers additional evidence in support of the suggestion that energy consumption is as a result of economic activity, rather than being a necessary input to production.

As for energy to GDP causality their results suggested that it is most common in the OECD country with 70% than the non-OECD countries with only 46% and the difference is very much bigger than that of GDP to energy. In conclusion, the extent o which energy use affects GDP is by large a lesser amount in developing countries than in the developed countries. Thus, causality from energy to GDP in general, increases at higher stages of development.

Co-integration relationship between energy consumption and economic growth using the granger causality test was used by Ansgar Belke, Christian Dragger, and Frauke de Haan for 25 OECD countries from 1981-2007 also taking into account the role of energy pricing. Based on their empirical findings, energy consumption, economic growth and energy price are co-integrated. This highlights the relevance of international development to explain energy demand. Furthermore the co-integration relationship suggests that energy consumption is relatively price inelastic. These underlines the theoretical expectation the energy use is mostly a necessity.

Narayan et al. (2010) examine the long-run elasticity's of the impacts on economic growth as a result of energy usage and also the impacts growth on the level of energy consumed for 93 countries during the time period from 1980 to 2006. They apply unit root tests and the co integration test of Pedroni (1999, 2004) to calculate long-run elasticity's between primary energy consumption and GDP. The estimated elasticity's based on a capital-driven production function, finding a significant coefficient showing the causal direction running from energy consumption to GDP. They compared their estimates obtained from the analysis with that obtained by other researchers in the field. This yields no much significant difference except for some nations.

Mohamed, Adel, Hatem, Rault (2014) in their study work as discussed earlier above discover in their case study that Economic growth causes energy use in Algeria given that Algeria is among the largest producers of energy (oil and gas) in Africa and a member of OPEC. The expansion of GDP is mainly caused by the expansion of the production of energy. But the reverse is the case which does not confirm the findings of Belaïd and Abderrahmani (2013) who find bidirectional causality for Algeria on electricity consumption and not all energy use. In the last scenario of their study, in the case of Ethiopia bidirectional causality is observed where GDP causes energy use positively, while energy use is causing negatively economic growth. The country is net importer of energy but it is trying to diversify its sources of energy by using renewable energies. The largest wind farm in the world was implanted in Ethiopia recently.

These results support that the causality between economic growth and energy use does not only depend on the stage of development of these countries as suggested by Pouman yvong and Kaneko (2010), but Energy endowments, urbanization, Demographics and economic policies may explain these differences in the causality between economic growth and energy use.

Chapter 4

TRENDS ON ENERGY USE IN THE WORLD

4.1 Introduction

For decades energy use has always been an important area of investment for development programs and improved economic activities necessary for economic growth worldwide. As discussed in the previous chapter, different Empirical evidence has shown that countries with high level of energy consumption experiences a substantial level of economic development. Hence energy consumption is imperative for economic growth process especially in developing nations. Therefore, in order to attain a certain level of development, consistent and efficient increase in the level of energy consumptions become necessary.

4.2 Global Trend

Global energy usage has increased on a steady base for decades with the majority of the increase in total consumption coming from developing countries or what is referred to as emerging economies (non OECD). Dynamics in the Energy market are progressively more controlled by these evolving economies. For example, Asia rapid growth in the demand for energy has eclipsed that of North America for the first time and is now referred to as the world most hungry energy region. (Globalization101, 2014) Most of the increase in these regions is from these large countries in Asia; China and India. China is speedily developing and the urgent need for energy is continuously increasing. (BP statistics, 2014)

Global primary Energy consumption is said to have increased by 2.31% in 2013, after the +1.8% increase in 2012. Despite The Growth in 2013 which speeds up in the oil, coal, and nuclear power sectors, aggregate growth was still on the 10-year average of 2.53%. Oil remains the world’s leading fuel, with 32.9% of global energy consumption. Oil consumption was higher in 2011, with 88million barrel of oil per day consumed globally but only .7% was consumed in 2010. (World Energy Statistical Review, 2012)

About 80% of the total global boost in energy consumption came from Emerging economies identified as non OECD countries, although the consumption growth rate in these countries was below average of about 3.1%. While in the industrialized economies known as the OECD countries, consumption here rose by 1.22% (above average). US growth rate in energy use records the highest in all of the net increase in the OECD regions by +2.9% and consumption in the EU and Japan fells by 0.3% and 0.6%, respectively. On the other hand, Spain experienced the largest degree of fall in total energy consumption with about -5%. (BP statistics, 2014)

Global energy use grew most quickly in the service and transport sectors, each with an increase of 37% and Coal recorded a leading role in the world's energy mix accounting for about 27% of the total energy use. These boosts were as a result of continues growth in activity in the various sectors for many countries; manufacturing industries were the sector that globally consumed the largest part of energy, accounting for about 33% of the total share. While the households sector accounted for about (29%) and transport sector (26%).

Before the rapid overall energy increase in 2012 and 2013, In 2009 world energy consumption decreased for the first time in 30 years, by 1.1% equivalent to 130 megaton's of oil as a result of the financial and economic crisis, which reduced world GDP by 0.6% in 2009. (EIA, 2013)

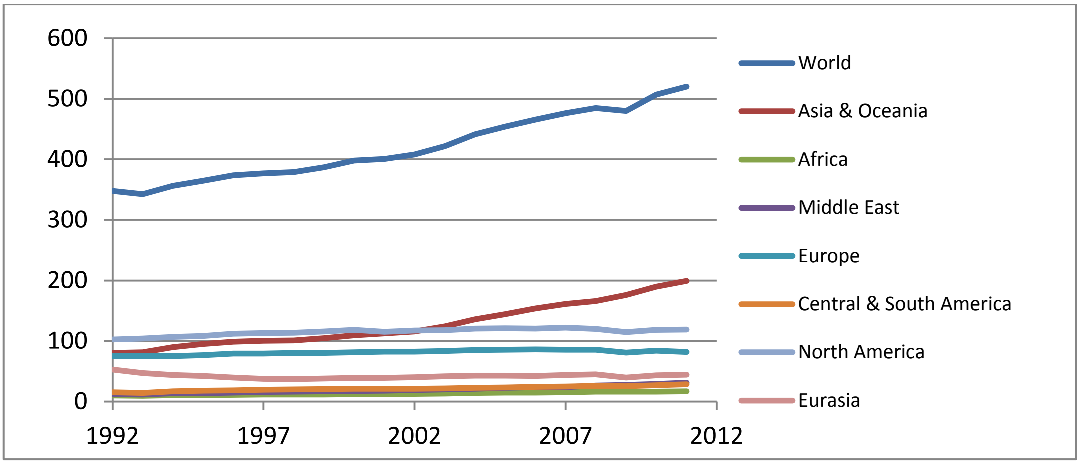

Figure 4.1: Global Energy Consumption by Region.

The Trends in total primary energy consumption fluctuates extensively amongst countries and regions as seen in figure 4.1. For this reason, further discussions on the trends in energy consumption will be done by dividing countries into main groups, according to categories for better analysis.

4.3 Energy Trends in Developed Countries

Developed countries are said to experience stagnant economies resulting from stable or decreasing energy consumption and high energy prices. These large economies consume more energy than the developing countries, but have much lower energy consumption growth. A very good example is the United State which has the highest total energy consumption but has a stable or what is referred to as 'flat' growth rate in total energy consumption. For simplicity, these countries have been categorized under the OECD countries to what is referred to as industrialized economics, (basically developed countries) made up of atypical group of governments who work together to deal with the economic, social and environmental issues of globalization. This group consists of highly developed economies among which are the Czech Republic, United States, Poland, Mexico, Portugal, Greece, Finland, Sweden, Ireland, Turkey, Japan, Germany, Hungary, Netherlands, New Zealand, Norway, Slovak Republic, and United Kingdom.

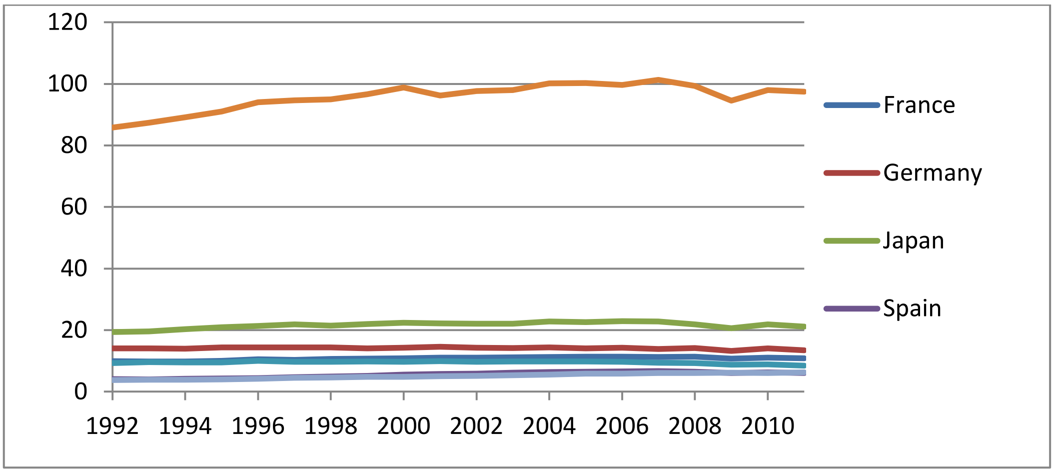

Figure 4.2: Global Energy Consumption by Region. (WDI, 2014)

These countries are said to consume up to 53% of world total energy consumption, but due to the varying in energy use amongst countries and region, energy use grew less quickly by +19% compared to developing countries which grew by 27%. In 2009 consumption was said to cut down severely by 4.9% which was followed by an increased by more than 5% in 2010 in the developed countries. And in 2011 it slow down by 2%. (EIA 2014)

In the developed economies, the growth rate in the level of energy consumption was generally due to constant growth in the transport sector contributing up to 35% of final aggregate energy consumption as of 2005. The service sector was the second rapidly emergent sector contributing 14% of aggregate energy use but its effect was insignificant. The manufacturing sector maintains a considerable large share of 27% in the overall energy use in the OECD countries, despite the insignificant increase in other sectors.(EIA, 2014).

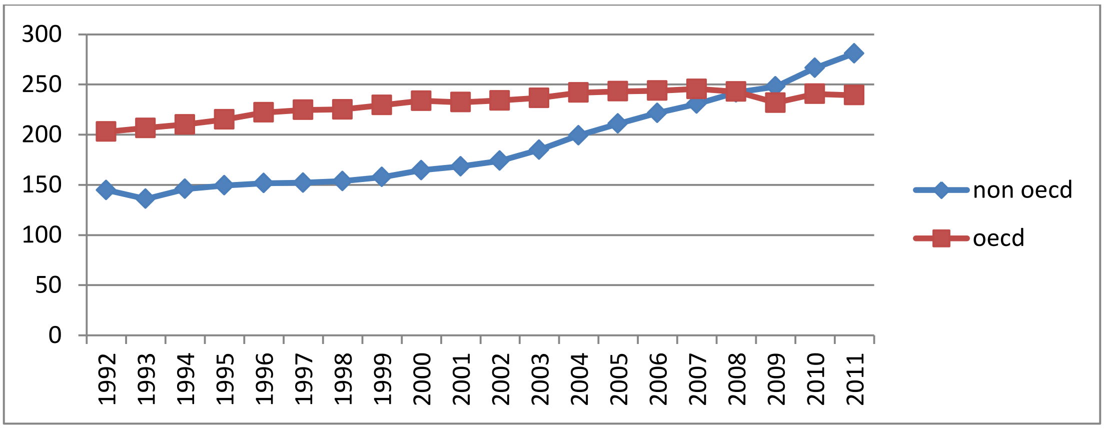

Figure 4.3: Total energy consumption (1992-2011, EIA 2014).

4.4 Energy Trends in Developing Economics

Energy consumption growth in several developing countries remains vigorous due to economic and regional differences, whereas it is expected that the developing nations would have the highest growth in demand for energy which will increasingly influence how new energy market evolve that will meet their economic needs. (EIA, 2008)

These New emerging developing economies are the prime destination for flow of energy investment. From 1990-2005 non OECD (mostly developing nations) economies have increased in energy use by 27%. From 2008 to 2035 these non OECD economies are expected to make up to 80% of total world energy demand growth round the globe. (Based on EIA projections) China, India and Brazil has accounted for 55% of overall energy demand while the rest of the developing countries accounted for just 28% of total global energy demand.(EIA 2012)

China has become one of the largest energy consumers in the world and this is due to its rapidly growing economy accounting for up to 18% of the total global energy consumption. Even though its consumption rose up by 8% in 2009 from a 4% increase in 2008, Oil has remained the principal energy resource in China (33%) regardless of the fact that oil contribution has been declining over time. The manufacturing and household sector also remains the dominating energy users, with a share of 38% and 36% respectively as of 2005. In contrast, notwithstanding the rapid growth from 1990 to 2005, the transport sector only contributes 17% of the total energy use in China. (IEA, 2008)

Trends in the cumulative final energy intensity show that developing economies have revealed a fall in consumption of energy. In a larger perspective, developing countries have shown a more rapid rate of reduction in energy usage than in developed countries.

4.5 OPEC Contribution to Global Energy Use

The Organization of Petroleum Exporting Countries OPEC is a large energy producing unit whose mission is to control and coordinate polices on oil production by providing secured and steady income to member states. OPEC was formed during the Baghdad Conference in September 1960, with the founding countries namely; Iraq, Saudi Arabia, Iran, Kuwait, and Venezuela with its headquarter sited at Vienna, Austria. It is presently made up of twelve member states namely;

Algeria, Angola, Ecuador, Iran Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirate, and Venezuela.

Some of the OPEC nations depend heavily on oil sales; these countries suffered severe economic adversity from the fall in demand for oil during the 1973 oil crisis. In that same year OPEC declared what is referred to as ‘oil embargo’. Oil price increased from $3 to $12 per barrel. One of the lasting effects of this period was a global economic collapse. Unemployment rose to the maximum percentage on record. Due to these effects industrial nations decided to reduce its dependence on oil and substituted for natural gas, coal and nuclear power.

OPEC Member Countries have made considerable additions to their oil reserves around the globe in the recent years. According to current estimates, (OPEC, 2014), almost 81% of the world's proven oil and natural gas liquid reserves are located in OPEC Member Countries, with the bulk of OPEC oil reserves in the Middle East, amounting to 66% of the OPEC total. These member countries produce about 40% of the world’s crude oil and about 60% of total petroleum trade internationally. Because of this market share, OPEC actions on oil prices can influence international oil price, stability in the Energy markets, continuous oil production, and environmental sustainability.

OPEC has remarkably performed a dynamic role in the effective provision of energy supply to the international markets, while it protects the economic interests of its member countries and the organization to a decent extent. Among these member countries are developing countries that critically rely on oil production as source of creating revenue. Oil is anticipated to remain the mainstream of the global energy mix, especially under low oil price. OPEC will become the major oil producer if this projection holds into the future. (Ali M, Saeed H, Kaveh M, 2012).

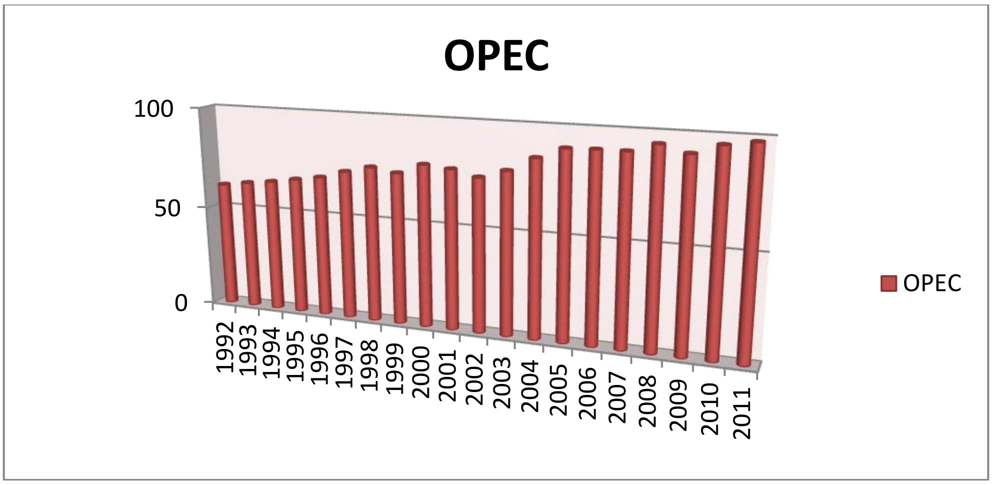

Figure 4.4: Total primary energy production by OPEC. (IEA statistics, 2012)

4.6 Global Energy Demand Projections

From the previous chapter, we have looked at various empirical studies that show the different casual direction between total energy consumption and economic growth for both developed economies and developing economies. In most developed countries the direction of causality is from GDP to total energy consumption. These entail that such economies have reached the peak of total energy consumption so that it doesn't cause economic growth. While, in most developing countries a positive relationship is established. Uni-directional causality from total energy consumption to GDP is gotten for these countries. It becomes important to look at the future of such emerging economics, how the level of energy consumption is projected to affect economic growth. Global energy demand is expected to be higher by 30% in 2040. According to the IEAs outlook (2012), its projects that greater global energy demands will come from non OECD countries.

For the OECD countries energy consumption pattern is expected to remain relatively stable or flat and energy use is projected to grow by 0.5% yearly relative to its population growth rate. While the fast growing economies (non OECD countries) with highly concentrated population will have significant energy consumption increase. This growth is projected to rise by 2.2% yearly and it is expected to have a share of a 65% from the world's total energy consumption in 2040 increase in energy demand.

4.6.1 Per Capital Consumption

Per capita consumption provides more elaborated information about the difference in energy usage among countries. Since 1980, the level of per capita energy usage has quite been stable globally. This implies that although global aggregate energy use has improved, most persons in different countries consume about the same energy they consumed 20years ago (globalization101, 2014). Thus we can say that the boost in total energy demand is relative to population growth and social transformation .USA for the past decades has experienced stable per capital energy consumption unlike in the case of china and India were millions of people has integrated into modern and urbanized communities due to the rapid industrialized transformation.(Globalization101, 2014)

Between 2010 and 2040, IEO 2013 projection shows that in the OECD countries per capita energy usage is anticipated to adjust by just a small amount from its 2010 level but a growth from 50MMBtu to 73MMBtu per capita energy consumption is expected in developing economies accommodated with a very high population growth. Although Africa and India has the most articulated population growth rate, the per capita energy consumption is low. It is expected that Africa will have an almost constant per capita energy use through 2040, but India per capita energy use is expected to grow during this period. As of 2011, countries like Saudi Arabia and Belgium already accounts for higher per capita energy consumption than that of the United States. (British Statistic, 2012)

Chapter 5

EMPIRICAL SPECIFICATION, DATA AND INTEPRETATION OF RESULT

5.1 Introduction

As discussed in the previous chapter, rapidly growing economies-basically developing countries have achieved some reasonable level of economic growth with the help of the energy sector. In this study the main objective is to check the causal trend between the level of energy consumed by an individual and GDP per capita considering twenty 20 developing countries for the period of 20 years.

5.2 Econometrics Model and Hypothesis

The assessment of the causal link between total energy consumption and economic growth can be examined in the context of a bivariate model. I choose two variables to explain the level of causality which are real GDP per capita and total primary energy consumption per capita.

GDP/cap= (Total primary energy consumption per capita) ………….............. (5.1)

TEC/cap= (GDP per capita)………………………………………..................…. (5.2)

Equation 5.1 and 5.2 can be put in a simple panel causality testing approach adopted by Dumitrescu-Hurlin panel test which allows all the coefficient in the model to be different across cross sections;

ΔGDP/cap$_t$= α_1 +$\sum_{i=0}^{n}\beta\, i\Delta$GDP/cap $_{t-i}$+ $\sum_{j=0}^{m}\lambda j$ ΔTEC/cap $_{t-j}$ + u…(5.3)

ΔTEC/cap$_t$ = α_2+ $\sum_{i=0}^{n}\gamma\, i\Delta$TEC/cap $_{t-i}$ + $\sum_{j=0}^{m}\delta j\Delta$GDP/cap $_{t-j}$ + $\boldsymbol{e}_t$……………....(5.4)

Where:

ΔGDP/cap = first difference operator of real GDP per capita (USD 2005)

ΔTEC/cap = first difference operator of total primary energy consumption per capita

$\alpha 1$, $\alpha 2$ = intercepts for equation (5.3) and (5.4) respectively

β, δ = parameters of GDP per capita which are sensitive to optimal lag length of m.

γ, λ = parameters of TEC per capita which are sensitive to optimal lag length of n.

i, j = country

t = year (1992, 1993…., 2011)

m, n = fixed maximum number of lags for each variable

u_t= random disturbance error term at time period for equation (5.3)

$\boldsymbol{e}_t$= random disturbance error term at time period for equation (5.4)

These equations are expressed in order difference I (1) form in order to show the stationary link.

In equation 5.3 the explanatory variable in this case is GDP/cap which relies on the independent variable TEC/cap. That is TEC/cap affects GDP/cap if the present value of GDP/cap is forecasted better by the past values of TEC/cap. In other words, if TEC/cap granger causes GDP/cap then TEC/cap assists to determine or forecast GDP/cap.

In equation 5.4 the dependent variable becomes TEC/cap which relies on the independent variable GDP/cap. This is because we are trying to find out the direction of causality between these two variables.GDP/cap will affect TEC/cap if the existing values of TEC/cap are better projected by including the past values of GDP/cap. This means that GDP/cap granger causes TEC/cap therefore GDP determines the level of energy use per capita.

Table 5.1: Prior expectations for each explanatory the variables.

Regressor	Effect
GDP/ cap	TEC/cap → GDP/cap
Total energy consumption per capita	GDP/cap→ TEC/cap

5.3 Data

For this empirical analysis the data used will be analyzed in details in this section. Annual data from 1992 to 2011 for twenty 20 developing countries mainly non OECD member countries is used to investigate the direction of causality between total primary energy consumption and economic growth. The countries selected for this analysis are grouped into regions;

Table 5.2: Countries by Region

Asia	**Africa**	**Middle east**	**South/central America**
Lithuania, Bangladesh Belarus, China, Indonesia Malaysia, Philippines, India, Pakistan, Russia, Ukraine.	Algeria, Egypt, Tunisia, Nigeria	Saudi Arabia, Iran, Turkey,	Venezuela, Brazil

The data for the above countries for gross domestic product per capita (GDP/cap) is obtained from the world development indicator at constant USD 2005 (WDI, 2014).While the data collected for total primary energy consumption per capita is obtained from the Energy information administration (EIA, 2014) and the BP statistics (2013).These sources are used because they are more reliable and efficient means of gathering relevant information. Other sources of materials used for this research are gotten from publications, journals and research material.

5.4 Descriptive Tables

The descriptive statistics for the logged GDP per capita and total primary energy consumption per capita are listed below respectively for each country used for this analysis in table 5.3 and table 5.4.

Table 5.3: Descriptive statistics for GDP per capita.

Country	Min	Max	Mean	Std. Dev	Variance	Skewness	Kurtosis
Lithuania	3800.498	9897.439	6419.252	2114.225	4469946	0.3692086	1.61042
Algeria	2265.893	3168.675	2704.974	337.0518	113603.9	0.1367007	1.33012
Bangladesh	279.5384	568.7266	387.8388	89.58778	8025.971	0.595818	2.14471
Belarus	1519.315	4782.09	2723.932	1063.695	1131447	0.6698228	2.01924
Saudi Arabia	2353.987	4640.977	3268.841	852.3613	726519.8	0.4714176	1.59747
China	562.7267	3120.93	1498.978	781.1433	610184.8	0.7106364	2.285754
Egypt	895.6911	1551.398	1186.743	213.9945	45793.66	0.3618546	1.975971
Indonesia	947.9723	1650.629	1228.603	196.0617	38440.19	0.6780135	2.83724
Iran	1958.982	3314.363	2497.424	467.7306	218771.9	0.4504568	1.712963
Malaysia	3559.517	6531.321	5086.188	854.9112	730873.2	0.0410914	2.027893
India	413.1093	1086.049	665.933	206.3084	42563.14	0.694475	2.228797
Philippines	963.2677	1431.158	1148.574	143.8115	20681.74	0.6032203	2.189025
Pakistan	562.1509	788.684	548.7217	85.45127	7301.919	0.50804	1.534899
Russia	3300.036	6649.402	4743.971	1192.749	1422651	0.4027889	1.664292
Tunisia	2154.182	3807.069	2901.887	582.0138	338740.1	0.1946557	1.64205
Turkey	5100.654	8413.318	6453.913	1009.162	1018408	0.4344014	1.900874

Ukraine	1123.41	2205.582	1635.219	394.488	155620.7	0.0162749	1.464343
Venezuela	4322.637	6509.555	5592.333	533.456	284575.3	-0.4563654	3.034235
Brazil	3911.571	5721.29	4641.352	517.1929	267488.5	0.7773171	2.511895
Nigeria	660.1789	1016.502	761.4494	118.7006	14089.82	0.8987417	2.380388

Table 5.4: Descriptive Statistics for TEC Per Capita

Country	**Min**	**Max**	**Mean**	**Std. Dev**	**Variance**	**Skewness**	**Kurtosis**
Lithuania	73.91288	128.9135	96.51334	12.09724	146.3432	0.4674263	4.05183
Algeria	38.87699	55.66813	44.72591	4.691452	22.00972	0.6693602	2.484412
Bangladesh	2.47497	6.42794	4.338883	1.328168	1.764036	0.2516563	1.748599
Belarus	91.15853	149.4661	108.4635	13.7607	186.3568	1.279218	4.808797
Saudi Arabia	164.9521	343.7981	246.6634	41.48478	1720.987	0.4024784	3.004792
China	24.67214	77.59456	42.04152	16.83015	283.2539	0.7915622	2.26285
Egypt	23.89987	42.11719	33.10231	5.586781	31.21212	0.1230491	1.928236
Indonesia	13.98104	26.0243	19.48089	3.656807	13.37224	0.4996481	2.150468
Iran	51.25352	122.33449	84.23969	23.48825	551.6979	0.2386016	1.685239
Malaysia	60.23562	110.5188	85.64206	13.90059	193.2263	-0.0908075	2.453846
India	9.86621	19.73579	14.14587	2.933461	8.605193	0.5487428	2.28089
Philippines	10.56141	14.03023	12.79812	1.002195	1.004395	-0.9181234	3.027959
Pakistan	1043303	14.13994	12.342	1.117462	1.24872	0.2685277	1.958267
Russia	163.8087	229.826	191.0329	16.95037	287.3152	0.2528093	2.685458
Tunisia	22.37087	35.78064	29.86737	3.99085	15.92688	-0.4034689	2.252829
Turkey	36.22173	61.81929	47.77368	7.482611	55.98946	0.2376855	2.033106
Ukraine	98.07637	165.2943	127.3829	15.13331	229.0169	0.6887435	3.827395
Venezuela	100.0039	136.9202	117.4574	7.477253	55.90932	0.3482288	4.554857
Brazil	31.92072	61.40038	48.31341	6.399045	40.94778	-0.4369067	3.981617
Nigeria	4.51814	7.72406	6.831533	0.8471479	0.7176596	-1.550902	4.576184

From table 5.2 the descriptive table on GDP per capita shows that Turkey, Lithuania, Venezuela and Malaysia has the highest mean respectively while Bangladesh Pakistan, India and Nigeria recorded the lowest mean. The standard deviation for this data ranges from the lowest with 85.45127 from Pakistan and the highest with 2114.225 from Lithuania.

From table 5.3 below, the descriptive table on total primary energy consumption per capita shows that Saudi Arabia seems to have the highest mean of 246.6634.As discussed from our previous chapter; Saudi Arabia has shown increasing demand for energy as well as in the supply of energy products. It is presently one of the highest oil producer and an OPEC member state. This increase is followed by Russia, Venezuela and Ukraine respectively. While on the other hand Bangladesh and Nigeria has the lowest mean in total energy consumption per capita. Nigeria also records the lowest standard deviation of 0.8471479 followed by Philippines, Pakistan and Bangladesh.

5.5 Empirical Result

5.5.1 Panel Unit Root Tests

In a long run estimation analysis, stationary of variables is very important so as to avoid spurious regression. Firstly, before any estimation of a model a unit root test should be carried out so to check whether variables are trend stationary at levels or not. This is because a standard empirical analysis may be rendered invalid if regressor is non-stationary. In Testing for unit root by computing the different types of test, gives statistic with normal distribution and a more powerful panel unit root test. The Levin, Lin & Chu test assumes common trends but allows the error term to be independent while it varies in Fisher tests allowing for individual unit root process.

$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{\lambda i} \beta_{ij} \Delta y_{ij} - x_{it}\delta + e t$ ....(5.5)

Assumes common $\alpha=\boldsymbol{\lambda}-1$while the lag order varies across the cross section. Under the individual panel unit root test, it allows variation across the section for each test. This is to test the null hypothesis that H_0: $\alpha=0$ (unit root) and the alternative H_1: $\alpha<0$ (no unit root).The statistics obtained under the different test at levels shows that at 5% level of significance we can accept the null hypothesis that the panel data is non-stationary.at first difference all test are stationary that is we can reject the null and accept the alternative hypothesis that no unit root. Therefore we can go further and test for co-integration.

5.5.2 Co-integration Test

One of the main objectives of this research work is to determine the long run relationship between energy consumption and economic growth. This can be done by testing for co-integration in which I adopt the Pedroni Residual Co-integration Test (1999). The panel co-integration test consists of 7 different statistics which are grouped into two parts, within dimension and between dimensions.

Table 5.5: Result of Pedroni Residual Co-integration Test

	Within-Dimension Weighted (5% level of significance)				
Group	**Statistic**	**Prob**	**Statistic**	**Prob**	**Remark**
Panel v- statistic	-2.436466	0.9926	-1.569244	0.9417	No co-integration
Panel rho-statistic	2.386418	0.9915	1.349356	0.9114	No co-integration
Panel PP statistic	1.944253	0.9741	0.600102	0.7258	No co-integration
Panel ADF statistic	1.339516	0.9098	0.204116	0.5809	No co-integration

From the table above, the first four statistics are based on pooling the residuals along the panel test (within dimension) which allows for heterogeneity across countries by putting into consideration time factor. While the second grouped statistics are based on pooling the residuals along the group test (between dimensions) of the panel. In this case it allows for heterogeneity of parameters across countries.

Table 5.6: Result of Pedroni Residual Co-integration Test

	Between-Dimension weighted		
Group	**Statistic**	**Prob**	**Remark**
Group rho statistic	1.543703	0.9387	No co-integration
Group PP statistic	0.497124	0.6904	No co-integration
Group ADF statistic	-0.093232	0.4629	No co-integration

Thus, with the null hypothesis which states that no co-integration against the alternative which state that common auto regression coefficient (within-dimension) and individual auto regression coefficient (between-dimension) -we cannot reject the null hypothesis for both groups and conclude that there is no long run relationship between energy consumption per capita and economic growth. Therefore we can go on and test for the granger causality test in first difference I (1).

I. Cross section specific results

ADF test (parametric technique) helps to eliminate the problem of autocorrelation by including adequate terms in order for the error term to be sequentially uncorrelated using the parametric technique. The basic difference and similarity between these two techniques is the methods at which they both handle serial correlation in the regression while they are similar in the sense that both are sensitive to structural breaks and works best only with large sample.

$\Delta Y_{i,t} = \alpha_i Y_{i,t-1} + \sum_{k=1}^{pi} \beta_{i,k} \Delta Yi_{,t-k} + \delta i X_{i,t} + \varepsilon_{i,t}$,…………………………….……….(5.6)

Where Δ represent the first difference operator and pi is the lag order which is allowed to vary across the i. while αi, β_{ik}, δ_i are the autoregressive coefficient and ei,t is the white noise error process.

The PP test which is a non-parametric technique does not require the selection level of serial correlation as in the ADF test. This technique eliminates high order serial correlation in a series by using the same estimation scheme as in ADF test but it adjust the statistics to test for heteroscadasticity and autocorrelation to ensure a simple first order autoregressive AR (1). The number of lags has been selected by the use of Schwarz information criteria SIC at lag order 1.

5.5.3 Pairwise Granger Causality Test

Granger causality test is based on the presence of stationary test for variables so as to reduce bias forecast. As noted earlier, a granger causality test using non-stationary variables may develop a spurious granger causality result. In the pair wise granger causality test, two variables are usually test together with an expectation of either these results;

- ✓ Unidirectional causality (X→Y, Y→X)
- ✓ Bidirectional causality
- ✓ No causality

To test for the pair wise granger causality test I will be applying the two approaches provided by E-views.

I. Stacked (Common Coefficients) Causality Test

The first approach is the stacked causality tests which treat the panel data set as one large stacked set of data without taking a lagged value of one cross section to the next cross section. This approach assumes that all coefficients are same across all cross section (common coefficient).

$\beta0_i=\beta0_j,\ \beta1_i=\beta1_j,\ \beta2_i=\beta2_j,\ \ldots\ldots\ldots\ \beta m_i=\beta m_j,\ \forall_{i,j}$ ……………………………… (5.7)

Table 5.7: Stacked (Common Coefficients) Causality Test

	Lag=1 Obs=360		**Lag=2 Obs=340**		**Lag=3 Obs=320**		**Remark**
Null hypothesis	**F-statistic**	**Prob**	**F-statistic**	**Prob**	**F-statistic**	**Prob**	
DLTECK does not Granger Cause DLGDPK	0.73508	0.3918	2.53749	0.0806	2.12451	0.0971	No causality
DLGDPK does not Granger Cause DLTECK	11.9160	0.0006	2.74862	0.0655	2.11768	0.0979	No causality

In the above table, based on the stacked common coefficient causality test we do not reject the null hypothesis in both directions. This implies that at a 5% level of significance we can accept the null hypothesis which states that GDP per capita does not granger cause energy use per capita and energy consumption per capita does not granger cause GDP per capita.

But looking at the table carefully we see that with lag 1 we can reject the null hypothesis under the second condition and say that GDP granger causes energy consumption per capita. This is because the p-value at (0.0006<0.05) is less than the 5% level of significance and the f-statistic (11.9160) is relatively larger (significant) compared to the rest. But under the lag two and lag three to test for robustness, the null hypothesis is not rejected. Therefore it becomes necessary to go ahead and test for causality using the second approach.

II. Dumitrescu-Hurlin (Heterogeneous or unequal coefficients) Panel Causality Tests

Based on this approach, it allows for all coefficients to be different or what is referred to as heterogeneous across cross section. This approach takes into account two different statistics. The first statistics Wbar-statistic, takes average of the test statistics, while the Zbar-statistic shows a standard (asymptotic) normal distribution. These two statistics provide the standardized version of the statistics and is easier to compute. The heterogeneous or unequal coefficients can be represented as follows;

$\alpha 0i \neq \alpha 0j$, $\alpha 1i \neq \alpha 1j$, …….., $\alpha mi \neq \alpha mj$, $\forall i,j$.. (5.8)

Just as in equation (5.3) which I will base my results on, we can see that the coefficients are heterogeneous or unequal stated in equation (5.7).

Each variable has a different coefficient across the section.

Table 5.8: Pairwise Dumitrescu-Hurlin Panel Causality test.

	Lag=1			**Lag=2 Obs=340**		**Lag=3 Obs=320**		**Remark**
Null hypothesis	**Wbar-statistic**	**Zbar-statistic**	**Prob**	**F-statistic**	**Prob**	**F-statistic**	**Prob**	
DLTECK does not Granger Cause DLGDPK	1.08316	-0.17173	0.8637	2.53749	0.0806	2.12451	0.0971	No causality
DLGDPK does not Granger Cause DLTECK	0.79751	-0.86566	0.3867	2.74862	0.0655	2.11768	0.0979	No causality

From the above table using the selected lag 1 by Schwarz information criteria SIC, we obtain the Wbar-statistic and Zbar statistics which permits for common factors in the cross equation covariance to be detached. As earlier on mentioned these statistics provide a standard version of the statistics. But however we can see form the p-value that the null hypothesis cannot be rejected at 5% level of significance. To check for robustness at lags 2 and 3, the same result is obtained. In this case we can conclude that the Pairwise Dumitrescu-Hurlin Panel Causality testis preferred and at 5% level of significance we can fail to reject the null hypothesis and say that GDP per capita does not granger cause energy consumption per capita and energy consumption per capita does not granger cause GDP for these developing economies. Notwithstanding, at 10% level of significance we can reject the null hypothesis under lags selection 3 that GDP per capita granger causes energy use per capita.

5.5.4 Heterogeneous Panel VAR Test

Heterogeneous panel VAR shows how shocks are transmitted across units which provides not only the average effects of the variables but also the cross sectional difference. Including a cross sectional dimension is a much more reliable tool in in identifying the transmission of shocks across variables. This also helps to determine how past tendencies have created the current situation and how we can use the current situation to predict the future. This can give a guide to policymaker's basic facts that they can use to build alternative scenarios and policies.

In this case we will be treating all variables as an endogenous variable and interdependent. This will help determine which of the variables act best as an endogenous variable. It is important to note that the granger causality test does not tell us the actual impact of one shock variable to the other. That is it does not indicate if the effect of causality is temporal or permanent. Thus, it becomes important to test for the heterogeneity panel VAR test. We start by using the stacked common coefficient test with lag 1 taking dependent variable to be GDP. The result obtained shows that the t-statistic is not efficiently significant although the p-value at 5% level is significant. Using energy consumption as the dependent variable also indicates that the t-statistics is not significant.

On the other hand, by using the common coefficient model with lag 1 we observe that both GDP and energy are jointly significantly. Although we have a positive shock response of energy consumption per capita to GDP, the shock response for GDP to energy consumption is insignificant. Taking energy as the endogenous (dependent) variable, it shows that the t-statistics (absolute value) and p-values are significant. We can then conclude that energy consumption per capita response to GDP shock is positively significant. Testing GDP as the endogenous (dependent) variable, energy consumption per capita shows an insignificant t-statistic of -0.857368 as well as the p-value (0.3918) which is more than 5%. This implies that energy consumed per capita is not significant in explaining economic growth.

Even though no causality was established for the named countries the heterogeneity panel VAR test has indicated that GDP has significant impact on energy consumption per capita while the level of growth in these countries does not determine amount of energy consumed per individual in the short run.

Table 5.9: Dependent Variable: DLTECK

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.015550	0.003974	3.913274	0.0001
DLTECK?(-1)	-0.123526	0.053111	-2.325821	0.0206
DLGDPK?(-1)	0.260601	0.075494	3.451950	0.0006
R-squared	0.034357	Mean dependent var	0.021110	
Adjusted R-squared	0.028948	S.D. dependent var	0.067024	
S.E. of regression	0.066046	Akaike info criterion	-2.588621	
Sum squared resid	1.557277	Schwarz criterion	-2.556237	
Log likelihood	468.9519	Hannan-Quinn criter.	-2.575745	

F-statistic	6.351013	Durbin-Watson stat	1.765918
Prob(F-statistic)	0.001949		

Table 5.10: Dependent Variable: DLGDPK

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.017094	0.002505	6.824750	0.0000
DLTECK?(-1)	-0.028701	0.033476	-0.857368	0.3918
DLGDPK?(-1)	0.498921	0.047584	10.48495	0.0000
R-squared	0.263690	Mean dependent var	0.030752	
Adjusted R-squared	0.259565	S.D. dependent var	0.048379	
S.E. of regression	0.041630	Akaike info criterion	-3.511714	
Sum squared resid	0.618689	Schwarz criterion	-3.479329	
Log likelihood	635.1084	Hannan-Quinn criter.	-3.498837	
F-statistic	63.92518	Durbin-Watson stat	2.174618	
Prob(F-statistic)	0.000000			

Chapter 6

CONCLUSION AND RECOMEMDATION

After a careful empirical study trying to test for the link between the level of energy consumed by an individual and its impact on economic growth for twenty 20 developing economies, different causality tests were systematically carried using recent techniques. Firstly, the result for co-integration using the Pedroni residual co-integration test showed that energy consumption per capita and GDP per capita are not co-integrated in the long run. since the co-integration relationship was identified as well as the lag selection which was based on the Schwarz information criteria SIC, I went further to carry on the pair wise causality test using two approaches namely the stacked causality test and the Dumitrescu-Hurlin heterogeneous causality test at first difference I (1) which I based my conclusion .The results showed that no causality was established between the two variables. Meaning that, the amount of primary energy consumption per capita does not cause GPD per capita and vice versa. This is in accordance with the energy per capita analysis by the world energy outlook (2014). Which states that even though global energy consumption is increasing (particularly in the developing economies) the level of energy consumed by an individual still remains the same. But in order to examine for the short run effect, I tested for heterogeneity panel VAR test which helps to indicate the direction of effect or shock of one variable on the other by providing opportunity to examine the short run dynamics or shocks without losing the long run relationship.

I realized that the direction of shock was from energy consumption per capital response to shocks from GDP. With the current trend in the world energy market as discussed in chapter 4, it is observed that the shock to economic growth is detrimental to the level of consumption in these developing countries. This is as a result of the consistent increase in the consumption and demand for energy in the world energy market mostly from developing economies (especially Asia-China and India). This has affected the level of energy production to increase tremendously over the years. As discussed in chapter 4, OPEC which is described as the world energy market as well as other oil producing countries, has shown consistent increase in oil production over the years relative to the increase in energy demand.

This study provide a result that is not far from the prior expectation however many emerging economies like Venezuela, Nigeria and Saudi Arabia are still dependent on primary energy resources whose economics depends on Oil production as the basic driver of economic growth and development. This study supports other research work amongst who are Mohammed Issa (2014), Olusegun Odulafo (2009), Mohammed, Abel (2014), Evan lau (2011) who also study different developing economies like Africa, Arab countries and some Asian countries and found out that no causality was established for these variables. Reasons for these diversions in results from other studies may include differences in the selection of regions, economic structure, research methodology and development polices.

In conclusion, the co-integration test suggest that the energy consumption and economic growth are not co-integrated in the long run for these developing economies and based on the panel VAR test we see that any changes to the level of economic growth may create some level of shocks to the level of energy consumption per capita in the short run. I will then suggest that policymakers and the Government should carefully look at the reasons for the shocks without neglecting the future effect and create policies that will strengthen the ongoing transformation in the energy sector and also provide adequate energy supply for efficient economic growth. It is therefore necessary for the government to have an integrated energy policy which will guide the future energy development policy to avoid policy conflicts. Also government should provide necessary incentives for consumers to use energy efficiently.

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APPENDICES

Appendix A: Panel Unit Root Tests

<u>Level: LGDPK</u>

Pool unit root test: Summary

Series: LGDPK1, LGDPK2, LGDPK3, LGDPK4, LGDPK5, LGDPK6, LGDPK7, LGDPK8, LGDPK9, LGDPK10, LGDPK11, LGDPK12, LGDPK13, LGDPK14, LGDPK15, LGDPK16, LGDPK17, LGDPK18, LGDPK19, LGDPK20

Date: 02/09/15 Time: 14:59

Sample: 1992 2011

Exogenous variables: Individual effects

Automatic selection of maximum lags

Automatic lag length selection based on SIC: 0 to 4

Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	7.75402	1.0000	20	372
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	8.99740	1.0000	20	372
ADF - Fisher Chi-square	15.0854	0.9999	20	372
PP - Fisher Chi-square	4.91131	1.0000	20	380

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

<u>**First differences:** LGDPK</u>

Pool unit root test: Summary

Series: LGDPK1, LGDPK2, LGDPK3, LGDPK4, LGDPK5, LGDPK6, LGDPK7, LGDPK8, LGDPK9, LGDPK10, LGDPK11, LGDPK12, LGDPK13, LGDPK14, LGDPK15, LGDPK16, LGDPK17, LGDPK18, LGDPK19, LGDPK20

Date: 02/09/15 Time: 14:54

Sample: 1992 2011

Exogenous variables: Individual effects

Automatic selection of maximum lags

Automatic lag length selection based on SIC: 0 to 2

Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-7.59548	0.0000	20	355
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.51854	0.0000	20	355
ADF - Fisher Chi-square	115.012	0.0000	20	355
PP - Fisher Chi-square	122.536	0.0000	20	360

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Level: LTECK

Pool unit root test: Summary
Series: LTECK1, LTECK2, LTECK3, LTECK4, LTECK5, LTECK6, LTECK7, LTECK8, LTECK9, LTECK10, LTECK11, LTECK12, LTECK13, LTECK14, LTECK15, LTECK16, LTECK17, LTECK18, LTECK19, LTECK20
Date: 02/09/15 Time: 14:56
Sample: 1992 2011
Exogenous variables: Individual effects
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.87120	0.1918	20	380
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.43272	0.6674	20	380
ADF - Fisher Chi-square	45.5581	0.2519	20	380
PP - Fisher Chi-square	45.6237	0.2498	20	380

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

First differences: LTECK

Pool unit root test: Summary
Series: LTECK1, LTECK2, LTECK3, LTECK4, LTECK5, LTECK6, LTECK7, LTECK8, LTECK9, LTECK10, LTECK11, LTECK12, LTECK13, LTECK14, LTECK15, LTECK16, LTECK17, LTECK18, LTECK19, LTECK20
Date: 02/09/15 Time: 14:56
Sample: 1992 2011
Exogenous variables: Individual effects
User-specified lags: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-21.1911	0.0000	20	360

Appendix B: Pedroni Residual Co-integration Test.

Pedroni Residual Co-integration Test
Series: LGDPK LTECK
Date: 01/20/15 Time: 23:59
Sample: 1992 2011
Included observations: 400
Cross-sections included: 20
Null Hypothesis: No co-integration
Trend assumption: No deterministic trend
Automatic lag length selection based on SIC with a max lag of 3
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefficients. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-2.436466	0.9926	-1.569244	0.9417
Panel rho-Statistic	2.386418	0.9915	1.349356	0.9114
Panel PP-Statistic	1.944253	0.9741	0.600102	0.7258
Panel ADF-Statistic	1.339516	0.9098	0.204116	0.5809

Alternative hypothesis: Individual AR coefficients. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	1.543703	0.9387
Group PP-Statistic	0.497124	0.6904
Group ADF-Statistic	-0.093232	0.4629

Appendix C: Stacked (Common Coefficients) Causality Test

Pairwise Granger Causality Tests
Date: 01/20/15 Time: 23:53
Sample: 1992 2011
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DLTECK does not Granger Cause DLGDPK	360	0.73508	0.3918
DLGDPK does not Granger Cause DLTECK		11.9160	0.0006

Check for robustness with lag = 2

Pairwise Granger Causality Tests
Date: 01/21/15 Time: 00:05
Sample: 1992 2011
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DLTECK does not Granger Cause DLGDPK	340	2.53749	0.0806
DLGDPK does not Granger Cause DLTECK		2.74862	0.0655

Check for robustness with lag = 3

Pairwise Granger Causality Tests
Date: 01/21/15 Time: 00:05
Sample: 1992 2011
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
DLTECK does not Granger Cause DLGDPK	320	2.12451	0.0971
DLGDPK does not Granger Cause DLTECK		2.11768	0.0979

Appendix D: Dumitrescu-Hurlin Panel Causality (Heterogeneous or unequal coefficients) Tests

Pairwise Dumitrescu-Hurlin Panel Causality Tests
Date: 01/21/15 Time: 00:06
Sample: 1992 2011
Lags: 1

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
DLTECK does not homogeneously cause DLGDPK	1.08316	-0.17173	0.8637
DLGDPK does not homogeneously cause DLTECK	0.79751	-0.86566	0.3867

Check for robustness with lag = 2

Pairwise Granger Causality Tests
Date: 01/21/15 Time: 00:08
Sample: 1992 2011
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DLTECK does not Granger Cause DLGDPK	340	2.53749	0.0806
DLGDPK does not Granger Cause DLTECK		2.74862	0.0655

Check for robustness with lag = 3

Pairwise Granger Causality Tests
Date: 01/21/15 Time: 00:08
Sample: 1992 2011
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
DLTECK does not Granger Cause DLGDPK	320	2.12451	0.0971
DLGDPK does not Granger Cause DLTECK		2.11768	0.0979

APPENDIX E: Heterogeneity Panel VAR Test.

Common coefficient

Dependent Variable: DLTECK?
Method: Pooled Least Squares
Date: 01/21/15 Time: 00:35
Sample (adjusted): 1994 2011
Included observations: 18 after adjustments
Cross-sections included: 20
Total pool (balanced) observations: 360

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.015550	0.003974	3.913274	0.0001
DLTECK?(-1)	-0.123526	0.053111	-2.325821	0.0206
DLGDPK?(-1)	0.260601	0.075494	3.451950	0.0006

R-squared	0.034357	Mean dependent var	0.021110
Adjusted R-squared	0.028948	S.D. dependent var	0.067024
S.E. of regression	0.066046	Akaike info criterion	-2.588621
Sum squared resid	1.557277	Schwarz criterion	-2.556237
Log likelihood	468.9519	Hannan-Quinn criter.	-2.575745
F-statistic	6.351013	Durbin-Watson stat	1.765918
Prob(F-statistic)	0.001949		

Dependent Variable: DLGDPK?
Method: Pooled Least Squares
Date: 01/21/15 Time: 00:35
Sample (adjusted): 1994 2011
Included observations: 18 after adjustments
Cross-sections included: 20
Total pool (balanced) observations: 360

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.017094	0.002505	6.824750	0.0000
DLTECK?(-1)	-0.028701	0.033476	-0.857368	0.3918
DLGDPK?(-1)	0.498921	0.047584	10.48495	0.0000

R-squared	0.263690	Mean dependent var	0.030752
Adjusted R-squared	0.259565	S.D. dependent var	0.048379
S.E. of regression	0.041630	Akaike info criterion	-3.511714
Sum squared resid	0.618689	Schwarz criterion	-3.479329
Log likelihood	635.1084	Hannan-Quinn criter.	-3.498837
F-statistic	63.92518	Durbin-Watson stat	2.174618
Prob(F-statistic)	0.000000		