NEAR EAST UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
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THE NEXUS BETWEEN ELECTRICITY CONSUMPTION, ECONOMIC GROWTH AND ENVIRONMENTAL POLLUTION: EVIDENCE FROM NIGERIA

BAKSHAK YERIMA SATI

MASTER'S THESIS

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ACCEPTANCE/APPROVAL

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I **Bakshak Yerima Sati**, hereby declare that this dissertation entitled '**The Nexus between Electricity Consumption, Economic Growth and Environmental Pollution: Evidence from Nigeria'** has been prepared myself under the guidance and supervision of '**Dr. Asil Azimli**' in partial fulfillment of the Near East University, Graduate School of Social Sciences regulations and does not to the best of my knowledge breach and Law of Copyrights and has been tested for plagiarism and a copy of the result can be found in the Thesis.

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ABSTRACT

THE NEXUS BETWEEN ELECTRICITY CONSUMPTION, ECONOMIC GROWTH AND ENVIRONMENTAL POLLUTION: EVIDENCE FROM NIGERIA

This thesis examines the relationship involving electricity consumption, economic growth, and environmental pollution within the framework of the Environmental Kuznets Curve (EKC) hypothesis. Johansen and Gregory Hansen Co-integration tests as well as Toda Yamamoto Granger Non-causality test were used to determine the long-run causal relationship among the variables in Nigeria from 1971 to 2014. The cointegration tests result indicate that there is no long-run relationship existing among EC per capita, GDP per capita and CO2 emissions per capita. Similarly, the result from Toda Yamamoto Granger Non-Causality test indicates that there is no causality relationship between the variables; hence supporting the neutraity hypothesis in Nigeria. The results from the diagnostic test for serial correlation, Heterosckedasticity, Jarque-Bera test for normality all show that there are no econometric problems with the estimated coefficients which confirms the robustness of the overall findings of the study. The study recommends policy beyond the traditional focus of EKC on GDP growth. Accordingly, government enforcement of environmental regulations, encouragement of the use of friendly environmental technologies and alternative clean sources of energy such as solar energy will mitigate the level of pollutions and stimulate economic growth.

Keywords: Electricity consumption; Economic growth; Energy; CO_2 emissions; Johansen Co-integration; Causality.

ÖZ

ELEKTRİK TÜKETİMİ, EKONOMİK BÜYÜME VE ÇEVRE KİRLİLİĞİ ARASINDAKİ NEXUS: NİJERYA'DAN OLAYLAR

Bu tez, Çevresel Kuznets Eğrisi (EKC) hipotezi çerçevesinde elektrik talebi, ekonomik büyüme ve çevre kirliliği arasındaki ilişkiyi incelemektedir. 1971'den 2014'e kadar Nijerya'daki değişkenler arasındaki uzun vadeli nedensel ilişkiyi belirlemek için Johansen ve Gregory Hansen Eş-bütünleşme testleri ve Toda Yamamoto Granger Nedensellik dışı testi kullanıldı. Eşbütünleşme testleri sonucu, uzun dönem olmadığını gösteriyor kişi başına EC, kişi başına GSYİH ve kişi başına CO2 emisyonu arasında mevcut olan ilişki. Benzer şekilde, Toda Yamamoto Granger Nedensellik Testinin sonucu değişkenler arasında nedensellik ilişkisi olmadığını gösterir; Bu nedenle Nijerya'daki sinirlilik hipotezini desteklemektedir. Seri korelasyon için tanısal test, Heterosckedastisite, Jarque-Bera normallik testinin sonuçları, çalışmanın genel bulgularının sağlamlığını doğrulayan tahmini katsayılarla ekonometrik bir sorun olmadığını göstermektedir. Çalışma EKC'nin geleneksel GSYİH büyümesine odaklanmasının ötesinde bir politika önermektedir. Buna göre, çevresel düzenlemelerin hükümet tarafından uygulanması, dost çevre teknolojilerinin kullanılmasının teşvik edilmesi ve güneş enerjisi gibi alternatif temiz enerji kaynakları kirlilik seviyesini azaltacak ve ekonomik büyümeyi teşvik edecektir.

Anahtar Kelimeler: Elektrik tüketimi; Ekonomik büyüme; Enerji; CO2 emisyonları; Johansen Eş Bütünleşmesi; Nedensellik.

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ABBREVATIONS

ADF test	Augmented Dicky-Fuller test
AIC	Akaike Information Criteria
ARDL	Auto regressive Distributed lag
BOD	Biological Oxygen Demand
CDM	Clean Development Mechanism
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
CH4	Methane
CFCs	Chlorofluorocarbon
EC	Electricity Consumption
ECM	Error Correction Model
EKC	Environmental Kuznets Curve
GDP	Gross Domestic Product
GH	Gregory Hansen
HQ	Hannan-Qunn Information Criteria
KPSS	Kwiatkowski, Philips, Schmidt & Shin
MENA	Middle Eastern and Northern Countries
MOEP	Ministry of Environmental Protection
NEEDS	National Economic Empowerment and Development Strategy
N_2O	Nitrous Oxide
NNPC	Nigerian National Petroleum Corporation
OLS	Ordinary Least Square
OPEC	Organization of Petroleum Exporting Countries
PP test	Phillips-Peron test
SAP	Structural Adjustment programme
SC	Schwarz Information Criteria
SO_2	Sulphur dioxide
SPM	Suspended Particulate Matter
UNECE	United Nations Economic Commissions for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VAR	Vector Auto Regressive model

VECM	Vector Error Correction Model
WDI	World Development Indicators

INTRODUCTION

The problem of global warming caused by environmental pollutants has become an important area of concern to many scholars and researchers all over the world. The environmental quality degradation resulting from economic, industrial and human activities of extractions and conversion of natural resources in the past decades has continued to increase over the recent years. The desire for a sustainable environment and economic growth has led to the investigation of the relationship between economic growth and environmental pollution by many researchers all over the world.

Different studies use different variables to proxy economic growth and environmental pollution. For example, gross domestic product (GDP), income, labour productivity, employment are used as proxy of economic growth while, CO_2, energy consumption, electricity consumption, chlorofluorocarbon, methane, nitrous oxide, sulfur dioxide, and carbon monoxide are used as proxy of environmental pollution (Oguntunde, et al., 2014).

Theoretically, it has been shown that a rise in economic growth may lead to a rise in environmental quality degradation but as economic growth increased up to a certain threshold level, environmental quality degradation starts to reverse back since developed economies would enforce environmental quality standard at this turning point, environmental quality degradation starts to improve (see also Kuznets, 1954/1955).

However, this position tends to give more relevance to raising GDP as a remedy of environmental pollution than critically focusing on the environmental problem itself. If the Environment Kuznets Curve (EKC) is generally the most important theoretical framework towards having a cleaner environment, then the large emissions from the advanced countries in the presence of substantial per capita GDP leaves much to be desired. Because it is expected that with increase in economic prosperity (GDP per capita), C02 emissions from these countries ought to be the lowest.

Therefore, this study makes use of Nigerian's secondary data to ascertain the validity of the hypothesis. It employs three different methodologies to achieve the research objective. Finally, practical policy proposals are supplied on the basis of the empirical outcome of the study.

CHAPTER 1
BACKGROUND OF THE STUDY

1.1 Introduction

The issue of environmental pollution fundamentally started when people grouped themselves and settled together in an environment for many years. The multiplication of people and places of settlement in those days brought about the problem of environmental pollution that has become a major concern today. Environmental pollution is primarily caused by human activities and economic activities such as burning of gas into the air, farming, and extraction of natural resources. The major environmental pollutions which are harmful to human health, wildlife, and the environment include air pollution, water pollution and land pollution (Ajeao & Anurigwo, 2002).

There is a growing literature by experts whose attempt was to examine the nexus between electricity consumption, economic growth and environmental pollution (measured by Carbon dioxide (CO2) emissions). However, these studies indicate the causality correlation between electricity consumption, economic growth (GDP growth), and CO_2 emissions. But the controversies is the variations in the directions of the causality relationship. For instance, the research carried out in both developed and developing countries by Hope & Morimoton (2004) for Sri Lanka from 1960 to 1998, Shiu & Lam (2004) for China from 1971 to 2000, Smyth & Narayan (2005) for Australia from 1966 to 1999, Singh & Narayan (2007) for Fiji Islands from 1970 to 2002, Atif & Siddiqi (2010) for Pakistan from 1971 to 2007 and Shahbaz & Fedidun (2012) for Pakistan from 1991 to 2008 discovered a unidirectional causality correlation between electricity usage, GDP growth and emissions of CO_2.

On the other hand, the studies conducted by Abbas & Choudhury (2013) for India from 1972 to 2008, Polemis & Dagoumas (2013) for Greece from 1970 to 2011, Kasperowicz (2014) for Poland from 2000 to 2012 and, Sekantasi & Okot (2016) for Uganda from 1981 to 2013 discovered a bidirectional causality correlation between GDP growth, use of electricity and emissions of CO2.

The causal nexus between the use of electricity and CO2 emissions are also examined in Nigeria by Akinbami & Lawal (2009), Akpan & Akpan (2012), Nnaiji, Chukwu & Nnaji (2013), Kivyiro & Aminen (2014), Emobi & Boo (2015), Lin, Omoju & Okonkwo (2015) and Kizikaya (2017). They report a causality moving from energy usage to CO2 emissions. Meaning that the type of energy consumed could influence the level of environmental pollution.

On the other hand, there are studies carried out in both advanced and developing countries (e.g. Bruce, Maya, & Madhusudan, 2002; Lopez, 1994; Shaffik & Bandyopahway, 1992). Their respective findings show support for Environmental Kuznets curve (EKC) hypothesis. This implies that the quality of the environment reduces at the initial stage of economic growth and eventually improve at the later stage when economic growth is achieved.

Similarly, there are studies on the nexus between economic growth and environmental pollution in relation to the EKC Hypothesis in Nigeria. For instance, the studies by Omisakin & Olusegun (2009) from 1970 to 2005, Akpan & Chucku (2011) from 1960 to 2008, Akpan & Akpan (2012) from 1970 to 2008, Alege & Ogundipe (2015) from 1970 to 2011, Aye & Edoja (2017) from 1971 to 2013 and Adu & Denkyirah (2018) from 1970 to 2013, fail to support the EKC hypothesis.

This shows that the nexus between economic growth and environmental pollution cannot be explained by an inverted U-shaped curve. On the other hand, Aiyetan & Olomola (2017) employed the ARDL bound testing techniques and Toda-Yamamoto non-granger causality method from 1980 to 2012 and provide support for the EKC hypothesis in Nigeria.

The above literature shows that there is variation in the nexus between the use of electricity, GDP growth and emissions of CO_2. Similarly, the research on the EKC hypothesis has produced mixed results in Nigeria. The non-support for the EKC hypothesis implies that the Nigerian economy is yet to achieve the level of income that will improve the quality of the environment at the turning point.

Therefore, the sound knowledge and understanding of the relationship between electricity usage, economic growth, and emissions of CO_2 are vital for Nigeria. Good knowledge of the nexus between electricity usage, GDP growth and environmental pollution by policymakers could enable them to make relevant policies that will help in providing efficient and clean energy capable of reducing environmental pollution as well as improving economic growth.

This study used updated data from 1971 to 2014 to contribute to the emerging discourse on the validity of EKC theory on the Nigerian economy. Similarly, the study contributes to the existing literature in terms of contextual application as well the methodological approaches (Johansen cointegration, Gregory and Hansen and Toda-Yamamoto). This is owed to the multiple techniques employed in reaching overall meaningful conclusion. This increases the robustness of the research.

1.2 Statement of the Research Problem

In the past decades, the world's energy demand and consumption have maintained a steady growth. Emerging markets and developing countries are accelerating economic development. Rapid population growth and urbanization have become the main force of the world energy consumption growth. However, the growing energy consumption, especially the consumption of non-renewable energy in large scale, has brought a lot of serious influence on the environment. The sustainable development of the economy and the human society has been under the threats of regional environmental pollution and large-scale ecological destruction.

Burning of carbon-related fuels since the age of industrial revolution of the 18th Century has speedily enlarged the absorption of atmospheric carbon dioxide, escalating the pace of global warming and causing changes in the climate. This has arisen to become one of the most important causes of the present ocean acidification given that it melts in water to produce carbon-based acid. Similarly, the accumulation of human-made greenhouse emissions into the Atmospheric weather upsets the natural world's radiative stability. Consequently, it raises the earth's surface heat or temperature. In addition, it tends to exert tremendous effects on the climate, rise in sea level and adversely affecting world agricultural output.

The effects of carbon dioxide on the environment are of considerable relevance. Note that Carbon dioxide (CO2) contributes principal share of the atmospheric gases leading to the issue of global warming and climate change. It is because of this issue that the Kyoto Protocol, an environment-based accord adopted in 1997 by several players to the United Nations Framework Convention on Climate Change (UNFCCC) was formed. This agreement essentially aimed at mitigating or lessening CO2 emissions in the world over (World Bank, 2019). Accordingly, this thesis is motivated by one of the most important problems of the current era, global warming.

There is the argument that most developing countries contribute significantly to gaseous emissions into the atmosphere as a result of the use of less clean production technologies. Nigeria, as one of the developing nations is struggling to achieve a certain level of development and economic growth. In this part of world, the quest to achieve high level of GDP often leads to considerable level of energy consumption especially (fossil fuel) which invariably increases gas emissions. In addition to the above, oil spillage and natural resources usage tend to increase the level of environmental degradation. Hence, the economic growth process in Nigeria is pollution intensive (Akpan & Akpan, 2012).

The greenhouse emissions in essence, reduces the quality of the environment, reduces output from economic sectors such like agriculture. It also increases health hazards and to some extent, social exclusion and ethnic conflicts as people migrate as a result climate change. Therefore, addressing the issue of global warming occasioned by gaseous emissions is of paramount importance, even in the Nigerian context. The need to understand the intricate nexus between economic growth and C02 emission is very important. This would assist in promulgating policies that would reduce environmental pollution; encourage the use of friendly technology and efficient use of electricity for economic ventures.

1.3 Research Objective

The link between C02 emissions, energy use, and GDP growth is a combination of the EKC and the energy consumption growth literatures. The EKC hypothesis hypothesizes that as GDP rises, emissions invariably rises as well until some threshold level of income is reached after which emissions begin to decline. Therefore, the objective and aims of the study are framed in line with the ensuing argument.

The overall objective of the thesis is to determine the nexus between C02 emissions, GDP and electricity consumption in Nigeria from 1971 to 2014. The specific aims of the study are formulated as follow:

i. To determine the validity of the Environmental Kuznets Hypothesis in the Nigerian context.
ii. To determine the long-run relationship, if any, among the variables.
iii. To determine the direction of causality, if any, among the variable
iv. To prescribe suitable and pragmatic policy suggestions in the light of the empirical outcomes.

1.4 Research Questions

Based on the aforementioned problem, this study carefully crafted the following research questions to address the objective set by the study.

i. What is the impact of electricity consumption on CO_2 emissions in Nigeria?
ii. Does economic growth have any impact on CO_2 emissions in Nigeria?

iii. Is there any long-run relationship between the variables (CO_2 emissions, electricity consumption and economic growth) in Nigeria from 1971 to 2014?

1.5 Research Hypothesis

The thesis proceeds to formulate the below testable hypotheses:

i. H_0:There is no relationship between GDP, electricity consumptions and CO_2 emission in Nigeria from 1971 to 2014

ii. H_1:There is a relationship between GDP, electricity consumptions and CO_2 emission in Nigeria 1971 to 2014

1.6 Significance of the Study

The quest towards achieving environmental sustainability has assumed a centre stage in most economic and political discourse in recent times. This study seeks to supply rich and practicable solution to the emerging problem of environmental pollution in Nigeria. The outcome of the thesis would be useful in policy making that will enhance sustainability of the environment and economic growth. Similarly, the findings of the thesis would be useful to the government to set emissions target, use clean and friendly technologies that will lessen C02 emissions; hence less damage to the environment.

1.7 Scope and Limitations of the Study

The study is restricted to the influence of electricity consumption and economic growth on C02 emission in Nigeria between the periods of 1971 to 2014. The choice of the scope is necessitated by the problem of getting data to the current date of carrying out this thesis. Similarly, the data were all obtained from the same source (World Bank Development Indicators). Therefore, various methods for testing the properties of the data were employed to ensure the stability of the data.

1.8 Overview of Methodology and Sources of Data

This thesis is a quantitative research. It basically makes use of secondary data to empirically achieve the research objective of the study. In this regard, annual time series are collected from World Bank Development Indicators relating to Nigeria from 1971 to 2014.

This thesis started with the application of Dickey-Fuller and Phillip-Perron unit root test to examine the characteristics of the time series to avoid porous results. Similarly, unit root with structural break was also conducted to for the robustness of the checks However, three distinct techniques were employed for the analysis. First, the Johansen co-integration test was carried to ascertain long run relationship between the series. Second, the Gregory-Hansen corroborates the preceding technique in the presence of structural break. Third, the Toda-Yamamoto (1995) Granger causality is used to determine the path of causation between the variables.

1.9 Brief Outline of the study

This thesis comprises of 6 chapters. In chapter1, background of the study, statement of the thesis problem, research questions, hypothesis, research objectives, and significance of the study, scope / limitations and a brief synopsis of methodological approaches of the study are highlighted.

Chapter 2 discusses the theoretical underpinning of the study: Environmental Kuznets Curve (EKC hypothesis). This is followed by a review of related literature in Chapter 3. The review started with the relationship between Economic growth and environmental pollution. Afterward, the correlation between electricity consumption and economic growth is examined. The third aspect literature reviewed has to do with the link between electricity consumption and environmental pollution. In addition, EKC in the Nigerian context; a brief overview of the Nigerian Economy and economic outlook of Nigeria are given.

In chapter 4, the methodology, data, and econometric models are presented. Similarly, the source and description of the data are provided.

The empirical analysis is carried out in chapter 5. Here, graphical unit root test and estimation of the model are conducted. The results are presented using suitable tables.

Chapter 6 clearly gives sufficient interpretation and discussions of the empirical outcomes and policy recommendations.

The last chapter of the thesis consists of the summary of the research findings and conclusion.

CHAPTER 2
THEORETICAL FRAMEWORK OF THE STUDY

2.1 Introduction

The problem of global warming caused by environmental pollutants has become an important area of concern to many scholars and researchers all over the world. The environmental quality degradation resulting from economic, industrial and human activities of extractions and conversion of natural resources in the past decades has continued to increase over the recent years. The desire for a sustainable environment and economic growth has led to the investigation of the relationship between economic growth and environmental pollution by many researchers all over the world.

Different studies have used different variables as proxy of economic growth and environmental pollution. For example, gross domestic product (GDP), income, labour productivity, employment are used as proxy of economic growth while, CO_2, energy consumption, electricity consumption, chlorofluorocarbon, methane, nitrous oxide, sulfur dioxide, and carbon monoxide are used as proxy of environmental pollution (Oguntunde, et al., 2014). Taken together, the economic growth process seems to increase pollution depending on the level of development of the country.

Theoretically, it has been shown that a rise in economic growth may lead to a rise in environmental quality degradation but as economic growth increased up to a certain threshold level, environmental quality degradation starts to reverse back since developed economies would enforce environmental quality standard at this turning point, environmental quality degradation starts to improve (see also Kuznets, 1954/1955). The following section describes the EKC hypothesis.

2.2 The Environmental Kuznets Curve Theory (EKC)

The origin of EKC is traced back to 1954 when Simon Kuznets observed the existence of inequality in income. According to Kuznets as countries economically develop, inequality in income distribution first increase and then decrease, following an inverted U-shaped relationship. The representation of the changing correlation between per capita income and income inequality in an inverted U-shaped gives rise to what is known as the “Kuznets Curve” (Kuznets 1955). If the specifications of the Kuznets Curve were true, the Kuznets relationship must form an inverted U-shaped as indicated in Figure 1 below:

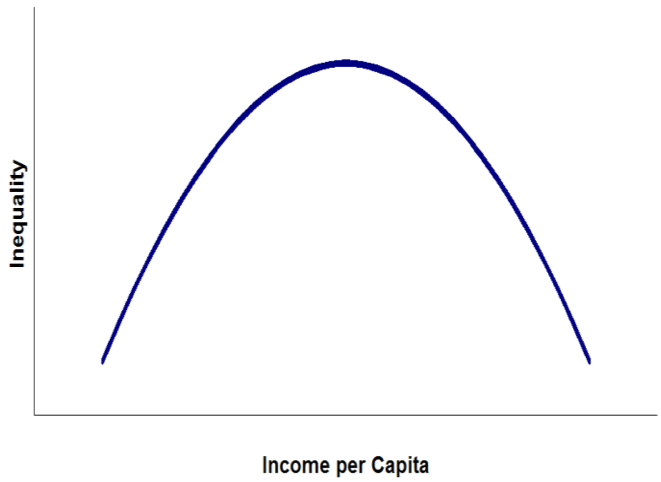

Figure 1: EKC hypothesis
Tejvan (2017): Economic Help

The Kuznets relationship begins to earn more recognition not only as a relevant instrument for measuring the nexus between change in per capita income and income inequality but for measuring the relationship between environmental quality and economic growth.

In this sense, GDP growth could be used as a remedy to ecological dilapidation to a certain extent than the cause of the quandary. The EKC proposition model emissions as a function of GDP which assumes one-way causality from GDP to C02 emissions. Nevertheless, it may well be the situation where a causality from C02 emissions to GDP whereby emissions take place at some stage in the production course and as a result GDP increases

The study by Grossman & Kreuger (1991) extends the Kuznets relationship into the environmental framework, EKC. The EKC hypothesis speculates an inverted U-shaped relationship between economic growth (GDP per capita) and environmental pollutants. They examine the correlation between income per capita and environmental degradation and reveal a systematic relationship that supports the EKC hypothesis between environmental emissions and economic growth (GDP per capita).

Since then, the EKC has been considered as a vital instrument for measuring the nexus between environmental degradation and economic growth. The curve has also partitioned into three sections. The first section is known as the level of environmental degradation, the second section is a turning point or industrial economics and the third section represents the post industrial service sector based economy. Figure 2 graphs the EKC relationship:

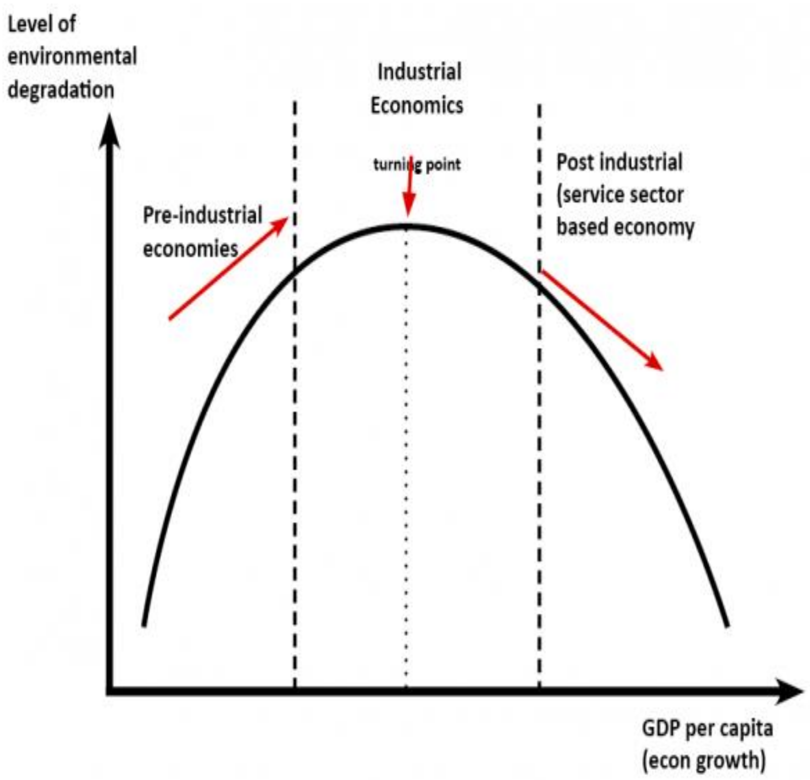

Figure 2: EKC hypothesis

Tejvan (2017): Economic Help

It is assumed that at the pre-industrial period, economic activities are done manually and low income is earned. The manual activities of the people may not have much effect on the environment compared to industrial activities. The EKC speculates that rise in trade liberalization will lead to a rise in production which requires more use of natural resources, leading to environmental emissions. This process of economic development has a negative effect on environmental quality. However, as the country continues to trade, its income level increases, people begin to demand cleaner environmental friendly technologies as well as the desire to change from industrial to services-based activities. The environmental emissions at this turning point start to reduce thereby improving the quality of the environment (Panayotou 1995 & Munasinghe 1999).

CHAPTER 3
LITERATURE REVIEW

3.1 Introduction

This chapter is set to discuss related empirical works written by various authorities that are relevant to the current topic on study. Here discussions are made based on the following sub-headings. First is the relationship between economic growth and environmental pollution. Second sub-heading consist of the relationship between electricity consumption and economic growth. Third sub-heading is the nexus between electricity consumption and environmental pollution. other sub-headings include the EKC hypothesis in Nigeria, Federal Republic of Nigeria, the Nigerian Economy, the Economy outlook of Nigeria, Electricity consumption per capita (kwh) in Nigeria and C02 emissions per capita (metric tons) in Nigeria.

The literature focuses on the methodologies used, the place of study, the time frame and the findings of the individual studies to have a broader and sound understanding of the current topic on study. This will equally enable this study to make relevant and appropriate conclusions that will contribute positively to finding a lasting solution to the problem of study.

3.2 Economic Growth and Environmental Pollution

The issue of global warming caused by environmental pollutants has become an important area of concern to many scholars and researchers all over the world. The environmental quality degradation resulting from economic, industrial and human activities of extractions and conversion of natural resources in the past decades has continued to increase over recent years. The desire for sustainable economic growth and environmental quality has led to the investigation of the relationship between economic growth and environmental pollution by many researchers all over the world. However, different studies use different variables to proxy economic growth and environmental pollution. For example, gross domestic growth (GDP), income, labour productivity, employment is used to proxy economic growth while, carbon dioxide (CO_2), energy consumption, electricity consumption, chlorofluorocarbon (CFCs), methane (CH_4), nitrous oxide (N_2O), sulphur dioxide (SO_2), and carbon monoxide (CO) are used to proxy environmental pollution to examined the relationship between economic growth and environmental pollution within the EKC framework (Oguntunde, et al., 2014).

According to the EKC hypothesis, a rise in economic growth may lead to a rise in environmental quality degradation but as economic growth developed up to a certain threshold level, environmental quality degradation starts to reverse back since developed economies would enforce environmental quality standard at this turning point, environmental quality degradation starts to improve (Kuznets 1955).

Ever since the 1970s, it was whispered that GDP growth-an indicator of the growth the economy would be the main cause for ecological Pollution. The inquiry that arose was whether there is a policy conflict involving GDP growth and C02 emissions, or whether GDP growth could be well-suited with the defence of the environment. From the time when the industrial revolution started, the global financial system has depended profoundly on non-renewable sources of energy and they stay put the leading source of energy universally. Through the World Summit symposium which took place in Rio de Janeiro in 1992 as well as the Kyoto meeting in 1997, higher importance began to be positioned on environmental effects. It is a fact global warming is a danger to humankind and its greatest cause is GHG emissions, chiefly make up of CO_2 emissions. Internationally, the CO_2 emissions emanating from non-renewable energy use and manufacturing enterprises increases which double between 1974 and 2014, rising from 16.9 to 35.5 Gt, (BP Statistical Review of World Energy 2015).

In a seminal paper, Grossman & Kreuger (1991) show that a rise in economic growth may lead to a rise in environmental quality degradation but as economic growth increased up to a certain threshold level, environmental quality degradation starts to reverse back since developed economies would enforce environmental quality standard at this turning point, environmental quality degradation starts to improve.

Similarly, earliest studies show that the correlation between the level of environmental quality degradation and per capita income supported the EKC. For instance, Shaffik and Bandyopahway (1992) employed panel regression for cross-sectional data from 1960 to 1990 for countries at different income levels. Their findings show that environmental pollutions increase at the early stage of economic activity as income rise but as the countries approach middle-income levels, environmental pollutions tend to reduce supporting the EKC relationship.

Lopez (1994) investigated the nexus between economic growth and environmental pollution and found that the relationship among them depends on the percentage change in the ratio between environmental pollution and traditional factors of production in relation to consumer's turning curve utility coefficient. Accordingly, as the elasticity of substitution and the corresponding curve coefficient increases, income level and pollution are likely to increase. This supports the EKC hypothesis.

The Study by Shaffik (1994) indicates that particulate and Sulphur dioxide (SO_2), dissolved oxygen, solid wastes, and carbon emissions worsen at the initial stage of economic growth but improve at the turning point of economic growth supporting the EKC relationship.

Lim (1998) examined the EKC relationship in Korea using SO_2, Nitrous Oxide (N_2O) and Biological Oxygen Demand (BOD) to measure environmental pressure and GDP to measure economic growth. The results show that economic growth has pressure on the quality of the environment at an early stage. Accordingly, the relationship between GDP growth and environmental pollution indicate an inverted U-shape upholding the EKC hypothesis.

There are recent studies that examined the relationship between economic growth and C02 emissions in relation to the EKC hypothesis in both develop and developing country. For instance, Ahmed and Long (2012) adopt Auto Regressive Distributed Lag (ARDL) bound testing and cointegration test in Pakistan from 1971 to 2008. Their findings show that economic growth and emissions of CO2 are cointegrated in both the short and long-run periods supporting the EKC hypothesis.

Similarly, Azomahou, Van, and Laisney (2001) used panel data and nonparametric model to investigate the link between economic growth and greenhouse gas emissions. Their findings show that there is a consistent relationship between GDP per capita and CO2 emission per capita. Accordingly, GDP has a negative impact on CO2 emission both in the short and long-run indicating no support for the EKC relationship.

In addition, Acharya (2009) employed the OLS and Co-integration techniques in India. The findings indicate that there is a long-run relationship between economic growth (GDP) and CO2 emissions. Accordingly, there is a unidirectional long-run causality running from GDP to CO2 emissions supporting the conservation hypothesis.

Furthermore, Annicchiarico, Bennato, and Costa (2009) employed cointegration, rolling regression and error correction techniques to examine the nexus between environmental pollution and GDP growth per capita in Italy from 1961 to 2003. Their results indicate that there is a significant correlation between economic growth and carbon dioxide emissions. Accordingly, pollutant CO_2 emissions decreases as income increases supporting the EKC relationship in the region

Tsai & Pao (2011) employed the Multivariate Granger Causality and panel co-integration techniques in Brazil, Russia, India, and China from 1992 to 2000. Their findings indicate that there is a long-run relationship between CO2 emissions and Economic growth (GDP) supporting the EKC relationship in China

Arouri, Youssef, M'henni, and Rault (2012) investigated the relationship between economic growth and environmental pollution. They used bootstrap panel unit root tests and cointegration techniques in 12 Middle Eastern and Northern Countries (MENA) from 1981 to 2005. Their results indicate that real GDP has a quadratic relationship with CO2 emissions in all the region. However, the turning point is not robust to support the EKC relationship between economic growth and environmental pollution.

Tang & Chand ran (2013) examined the EKC hypothesis using Co-integration and Granger Causality in ASEAN-5 countries. Their findings indicate that there is a long-run relationship between CO2 emissions and economic growth in Thailand, Malaysia, and Indonesia. However, the inverted U-shape EKC relationship does not apply to any of the ASEAN-5 countries. The Granger Causality showed a bi-directional effect between CO2 emission and economic growth in Thailand and Indonesia whereas, unidirectional causality between CO2 emission and GDP in Malaysia. According to them, adequate management of energy consumption may reduce CO2 emission to a lower level.

Furthermore, Begum, Sohag, Abdullah & Jaafar (2015) used ARDL bound testing in Malaysia from 1970 to 2009. Their findings show that there is a negative relationship between CO2 emissions per capita and economic growth (GDP) in the short run indicating no support for the EKC relationship in Malaysia. According to their results, there is a unidirectional causality running from economic growth and energy consumption supporting the conservation hypothesis.

Armeanu, Vintila, Andrei, Gherghina, Dragoi, and Teodor (2018) investigated the EKC hypothesis using pooled Ordinary Least Square (OLS) regression with Driscoll-Kraaystandard error and Vector Erro Correction Model (VECM) in EU-28 countries from 1990 to 2014. Their results show support for the EKC hypothesis in the case of sulfur oxide emissions and non-methane emissions. Furthermore, the findings from VECM analysis indicate that causality runs from GDP per capita to greenhouse gas emissions in the short run and a two-way causality between energy usage and greenhouse gas emissions. No, prove of causality between GDP growth and energy usage found which show support for neutrality hypothesis.

3.3 Electricity Consumption and Economic Growth

Ozturk (2010) opined that the causal relationship among electricity usage, GDP growth, and CO_2 emissions could be classified into four hypotheses such as (i) conservation hypothesis, (ii) growth hypothesis, (iii) neutrality hypothesis and (iv) feedback hypothesis. A unidirectional causality running from economic growth to energy consumption shows support for the conservation hypothesis meaning that conservation plans could be implemented without any effect on the economic growth. A bidirectional causality between economic growth and electricity consumption indicate support for the growth hypothesis which implies that expanding energy policies will stimulate economic growth. In other words, the hypothesis suggests a two-way causality between the variables. The growth hypothesis assumed that energy is the key factor of production. Thus, the reduction in energy supply would negatively impact on economic growth. Lack of causality among GDP growth, electricity usage, and CO_2 emissions upholds the Neutrality hypothesis. The policies implication for this hypothesis is that neither the expansion policies nor conservation energy policies cannot affect economic growth or energy consumption and CO_2 emissions. Therefore, the policy implications essentially depend on the causal relationship and the expected behaviour of the economy to ensure efficient energy policies that would enhance economic growth as well as environmental protection (Hajko, 2012).

Kraft and Kraft (1978) employed Causality test to examine the causality between energy consumption and Gross National Product in USA from 1947 to 1974. Their findings show that there is a unidirectional causality running from Gross National Product to Energy Consumption showing support for the Conservation hypothesis.

Hope & Morimoto (2004) used Standard Ordinary Least Square (OLS) regression to investigate the relationship between GDP and Electricity production consumption in Sri Lanka using Yan's Granger Causality model. Their analysis indicates that electricity supply have significant impact on real GDP.

The result of the research conducted by Shiu and Lam (2004) in China indicates a unidirectional Granger causality running from electricity consumption to economic growth. Similarly, Jumbe (2004) document a bi-directional Granger causality between economic growth (GDP) and electricity consumption in Malawi from 1970 to 1990. Their ECM test indicates a long-run causality running from GDP to electricity consumption indicating that an increase in economic growth will result in an increase in electricity consumption. Their result provides support for the conservation hypothesis

Yoo (2005) used the Cointegration and Error-correction model covering the period of 1970 to 2002 in Korea. Their findings indicate that there is a bidirectional causality connecting electricity and economic growth. Meaning that a unit change in electricity influences economic growth and a change in economic growth will also influence the consumption of electricity in Korea supporting the feedback hypothesis.

Similarly, Smyth & Narayan (2005) obtained data covering the period of 1966 to 1999 to analyse the correlation connecting electricity consumption, and GDP in Australia. The Multivariate Granger Causality analysis shows a unidirectional causality running from GDP to Electricity consumption. However, electricity consumption caused GDP in the short run while both electricity Consumption Caused GDP and GDP Caused Electricity Consumption in the long run**.**

Similarly, Altinay and Karagol (2005) adopt Granger causality a Dolado Lutketpohl test the associations between electricity consumption and economic growth covering in Turkey from 1950 to 2000. Their findings show that there is robust evidence of unidirectional causality running from electricity consumption to income. Therefore, there is a need for an adequate supply of electricity to serve the increasing demand for electricity consumption and for sustainable economic growth.

Squali (2007) use cointegration bound test and causality test in Organization of Petroleum Exporting Countries (OPEC) and found that there is long-run equilibrium correlation connecting electricity use and economic growth in all the OPEC members. The causality test indicates that five countries economic growth depend highly on electricity use. While three member countries depend less on electricity consumption for their economic growth.

Similarly, Akinlo (2009) adopt the cointegration test and Granger causality test in Nigeria from 1980 to 2006. Their findings show that there is a long-run equilibrium correlation connecting electricity use and economic growth during the period under review. Accordingly, there is a unidirectional Granger causality moving from electricity to economic growth.

Atif & Siddiqi (2010) examined the causality connecting GDP growth and electricity usage using the Engle-Granger cointegration and Granger Causality test in Pakistan covering the period of 1971 to 2007. Their results indicate that economic growth and electricity usage are not correlated in the long-run. Accordingly, a one-way causality runs from electricity usage to GDP growth supporting the conservation hypothesis in Pakistan.

Ouedraogo (2010) adopt Cointegration and causality test in Burkina Faso from 1968 to 2003 and found that there is a long-run equilibrium correlation connecting electricity use and economic growth. Accordingly, there is a bidirectional causality correlation connecting economic growth and electricity use supporting the feedback effect in Burkina Faso.

Similarly, Lean & Smyth (2010) used panel Vector Error Correction Model (VECM) to evaluate the causal correlation connecting CO2 emissions, electricity consumption and GDP in five ASEAN countries from 1980 to 2006. Their result shows that there is a long-run positive and significant correlation connecting electricity consumption and CO2. According to their findings, CO2 emissions and real output exhibited an inverted U-shaped relationship indicating support for EKC relationship. However, the direction of long-run causality was not identified.

Zhaonping & Meng (2011) adopt a random effect model and panel cointegration in South Asian countries spanning 1980 to 2010. Their results indicate that there is a long-run correlation connecting electricity use and economic growth. Accordingly, electricity use has a positive and significant influence on economic growth. Furthermore, their result shows that there is a unidirectional Granger causality moving from electricity use to economic growth supporting the conservation hypothesis in South Asian countries.

Shahbaz & Fredidun (2012) investigate the correlation connecting electricity consumption and economic growth using Autoregressive Distributed Lag (ARDL) bounds testing and Toda-Yamamoto &Wald-test in Pakistan spanning from 1991 to 2008. Their findings show there is a long run equilibrium correlation connecting electricity consumption and economic growth. Accordingly, there is a unidirectional causality moving from economic growth to electricity consumption supporting the conservation hypothesis in Pakistan.

Polemis & Degums (2013), examined the short and long run correlation connecting GDP and Electricity consumption using cointegration and Vector Correction Model in Greece spanning from 1970 to 2011. Their findings suggest a bidirectional relationship. Accordingly, their findings indicate that electricity consumption tends to be income elastic and price inelastic in the long run.

Abbas & Choudhury (2013) adopted Engle and Granger Causality test and OLS method to determine the causality connecting economic growth and electricity consumption in Pakistan, South Asia and India from 1972 to 2008. Their findings show that in India, there is bi-directional causality connecting electricity consumption and GDP growth supporting the feedback hypothesis. Whereas, the Engle and Granger Causality in Pakistan indicates that there is a causality moving from GDP growth to use of electricity supporting the conservation hypothesis.

In addition, Ogundipe & Apata (2013) use Johansen & Juselius Co-integration test, VECM, and Pairwise Granger Causality test in Nigeria from

1980 to 2008. Their study reveals that electricity influence economic growth in the long-run. Accordingly, there is a bidirectional causal correlation connecting electricity use and economic growth supporting the feedback hypothesis.

Furthermore, Akin wale, Jesuleye, & Siyanbola (2013) carried out a study in Nigeria from 1970 to 2005 using Vector Autoregressive (VAR) and VCM. Their result indicates that there is unidirectional causality moving from economic growth to electricity use which fails to support the feedback hypothesis.

Aslan (2014), Altinay & Karagol (2005) and Gokten & Karatepe (2016) in their respective studies found that there is a long-run equilibrium relationship between electricity consumption and economic growth in Turkey.

Linh and Lin (2014) used Cointegration and Granger causality test in Vietnam from 1980 to 2010. Their findings indicate that there is causality running from income per capita to energy consumption supporting the conservation hypothesis in Vietnam

Kasperowicz (2014) examined causal relationship between electricity consumption and economic growth in Poland from 2000 to 2012. The findings show the existence of bidirectional causality between electricity consumption and economic growth (GDP) supporting the feedback hypothesis in Poland.

Njindan (2014) made use of VECM to examine the causal correlation between electricity consumption and GDP growth covering the period of 1971 to 2012. The result shows that there is a causality moving from electricity usage to GDP growth supporting the electricity-led growth hypothesis.

Akomolafe &Danladi (2014) employed the Johansen Cointegration test, VECM and Granger causality test in Nigeria from 1990 to 2011. Their findings indicate that there is a long-run correlation connecting electricity use and economic growth. Accordingly, there is unidirectional Granger causality moving from electricity use to economic growth meaning that Nigeria highly depends on electricity for its economic activities.

There are studies conducted in Nigeria which found unidirectional causality moving from the use of electricity to economic growth. For instance, the study by Akinlo (2009), Akinwale, Jesuleye, & Siyanbola (2013), Akomolafe & Danladi (2014), Iyeke (2015) and Ogundipe & Apata (2013) reveals that there is a one-way causality running from electricity usage to Gross Domestic Product growth supporting the conservation hypotheses.

Similarly, Squalli (2007) in Organization of Petroleum Exporting countries (OPEC), Ouedraogo (2010) in Burkina Faso, Kasperowicz (2014) in Poland, Jannel & Derbali (2016) in Asian countries, Sekantasi & Okot (2016) in Uganda and, Jiang & Bai (2017) in China in confirm that there is a long-run equilibrium correlation connecting electricity usage and GDP growth. In general, there is a bidirectional causality connecting the use of electricity and GDP growth supporting the feedback hypothesis.

Similarly, Aslan (2014) carried out a study in Turkey from 1971 to 2007 using Autoregressive Distributed Lag Bound test and Granger causality test. The findings show that there is long-run correlation connecting electricity use and economic growth. Accordingly, the Granger causality test supported the neutrality hypothesis in the short run. However, there is bidirectional Granger causality between electricity use and economic growth in the long-run supporting the feedback hypothesis in Turkey.

Saidi & Hammami (2015) employed Johansen cointegration technique to determine the correlation connecting energy consumption and economic growth in Tunisia. Their findings show that there is a bidirectional causality correlation moving between energy consumption and economic growth (GDP) in the long run supporting the feedback hypothesis.

Similarly, Behara (2015) examined the correlation linking energy consumption and economic growth in India from 1970 to 2012. The findings show that there is a unidirectional causality moving from economic growth to energy consumption supporting the conservation hypothesis in India.

Chen, Wang, Ma, Wang, Cao and Ren (2016) employed Granger causality and Cointegration test in Sichuan province of China. Their findings show that there long-run equilibrium correlation connecting electricity consumption and economic growth. The Granger causality results indicate that electricity use has an influence on economic growth in Sichuan.

Another current study by Iyeke (2015) investigated the relationship between electricity use and economic growth in Nigeria from 1971 to 2011 using the VECM model. The findings indicate that there is a unidirectional causality in the short run and long-run running from electricity consumption and economic growth supporting the electricity-led growth hypothesis in Nigeria.

Jannel & Derbali (2016), employed VECM approach in Asian Countries from 1991 to 2013. Their results indicate that there a bidirectional causality relationship between electricity consumption and economic growth supporting the feedback hypothesis in Asian countries.

Sekantasi & Okot (2016) used Autoregressive Distributed Lag-bounds and Granger Causality model to determine the causal relationship between economic growth and electricity consumption in in Uganda from 1981 to 2013. Their findings indicate that there is a two-way relationship between electricity consumption and economic growth supporting the feedback hypothesis. However, in the short run, the Granger Causality analysis attested to the conservation hypothesis

Lu (2016) employed panel Cointegration test and Granger causality test in Taiwan from 1998 to 2014. Their result shows that there is a long-run equilibrium relationship between electricity consumption and economic growth. Accordingly, there is a bidirectional Granger causality between electricity and economic growth. However, electricity consumption appeared to boost the real GDP by 1.7% supporting the conservation hypothesis in some industries in Taiwan.

Another recent study by Gokten & Karatepe (2016) investigated the correlation connecting electricity consumption and economic growth in Turkey and found that there is unidirectional causality moving from electricity use to economic growth supporting the conservation hypothesis in Turkey.

A recent study by Shahbaz, et al (2018) employed the quantile–on-quantile approach of Sim and Zhou (2015) in India, China, Canada, USA, South Korea, Brazil, Germany, France and Japan. Their results show that there is positive relationship between economic growth and energy consumption in all the countries.

Similarly, their findings also indicate a little influence of economic growth on energy consumption in the lower quantiles economic growth countries and for highest quantiles of income countries. Accordingly, their results support the conservation hypothesis in china, Germany, France and India while, USA, Brazil, South Korea and Canada does not support the conservation hypothesis.

3.4 Electricity Consumption and Environmental Pollution

The discovery and extensive consumption of electricity are essential cryptograms of the next industrial revolution. Given the swift expansion of human population, growing of urban size and hastening of industrialization, electricity has turn out to be one of the most important motivating forces to encourage the GDP growth and social development around the globe.

On the other hand, with huge utilization of energy, resource exhaustion as well as ecological greenhouse gasses harms has turn out to be more and more severe. Fossil energy at the moment takes the dominant place in Nigeria. Consequently, Nigeria ought to employ effective steps and strategies in order to hasten p the fine-tuning of other energy sources. Therefore, it becomes imperative to satisfy the objective of GDP growth at the same time lessening ecological toxic waste.

Electricity is a form of energy used for industrial and household production. Most developing countries in the world depend on electricity for their economic activities. Although, electricity is a cleaner source of power the process of generating it causes environmental pollution through the combustion of fossil fuels (Pulles & Appelman, 2008).

The problem of the majority of the developing countries is the inability to implement energy renewal policies that may have a significant influence on the reduction of CO2 emissions and other environmental pollutants.

Ibitoye and Akinbami (1999) investigated Nigeria's energy-sector and the CO2 emission mitigation option and found that Nigeria has win-win options as policy towards mitigating CO2 emissions but has failed to reduce the level of CO2 emission due to lack of proper policy implementation.

Ahuja and Tatsuntani (2009) stated that about 1.6 billion people in the world cannot afford the electricity to carry out their daily economic and home activities. Accordingly, developing and emerging economies faced inadequate electricity supply as well as the inability to utilize alternative clean sources of energy that will reduce environmental pollution and sustain the economy.

They added that the effect of electricity generation and transmission on the environment has received attention from the US government. The United States has made laws towards controlling the effects of electricity generation and transmission on the environment. The Clean Air Act appears to have assisted in the substantial reduction of some major air pollutants in the United States.

This achievement was possible because the Environmental Protection Agency (EPA) in addition, sets emissions standards through Acid rain

Program (EIA, 2018). Similarly in Minnesota electricity generation has been considered to be the major sources of air pollution. It is the second-largest source of greenhouse gas emission. However, in order to mitigate greenhouse emissions across all sectors of the economy, a Next-Generation Energy Act is established (MPCA).

Akinbami & Lawal (2009) adopt the Model for Analysis of Demand for Energy, econometric and engineering techniques in Nigeria. Their findings are robust to explain the influence of electricity growth on CO2 emissions in Nigeria. Kumar (2011) adopt VAR and Granger causality techniques to examine the causality relationship between electricity consumption and CO2 emissions in India. The result indicates that energy consumption positively influence CO2 emissions

A study carried out by Akpan & Akpan (2012) adopt Multivariate Vector Error Correction Approach to evaluate the existence of a long-run relationship between CO2 emissions and electricity consumption in Nigeria covering the period of 1970 to 2008. The result shows that electricity consumption exhibits a significant and positive relationship with CO2 emissions. The positive signs exhibited by electricity consumption on CO2 emissions implies that the economic growth process in Nigeria is pollution-intensive.

Nnaji, Chukwu, and Nnaji (2013) used the bound test and Granger causality test causality relationship between electricity supply and CO2 emissions in Nigeria from 1971 to 2009. Their findings show that there is a short-run and long-run relationship between electricity supply and CO2 emissions. Accordingly, electricity positively influence CO2 emissions.

Al-mulali & Tang (2013) in their study confirmed that energy consumption and GDP increases CO2 emission in the gulf cooperation council (GCC) countries. Accordingly, energy consumption and GDP have positive significant causality running to CO2 emission supporting the EKC relationship GCC countries

Similarly, Sulaiman (2014) adopt the Granger causality test by Toda and Yamamoto in Nigeria to examine the causal relationship between CO2 emissions and energy use. The result indicates that there is a unidirectional causality running from energy consumption to CO2 emissions. This implies that energy consumption has an influence on environmental pollution in Nigeria.

Kivyiro & Arminen (2014) carried out a study in Sub-Saharan countries using ARDL model. Their result shows that there is unidirectional Granger causality running from energy consumption and GDP to CO2 emissions in different countries.

Emobi & Boo (2015) employed the Logarithmic Mean Divisia Index (LMDI) to examine the impact of electricity on CO2 emissions in Nigeria. Their results show that there is a reduction in CO2 emission from electricity generation. Accordingly, the empirical analysis shows that electricity consumption influences CO2 emissions in Nigeria.

Lin, Omoju, & Okonkwo (2015) employed Johansen's cointegration and VECM model in Nigeria from 1980 to 2011. Their findings indicate that energy intensity and carbon intensity exhibits an impact on CO2 emissions. The study by Tang & Tan (2015) shows that energy consumption positively influences CO2 emissions. Their result indicates support for the EKC hypothesis as CO2 exhibits an inverted U-shaped relationship with economic growth in Vietnam. Chindo, Abdulharin, Waziri, Huong & Ahmad (2015) conducted a study using the ARDL model in Nigeria. Their findings indicate there is a long-run correlation connecting energy consumption and CO2 emissions. However, their findings show that in the short run, energy consumption has a negative and significant impact on economic growth.

Sbia, et al. (2015) used ARDL and Granger causality test in Portugal to examine the long-run correlation connecting CO2 emissions and electricity consumption. Their findings show that there is bidirectional causality between electricity consumption, CO2 emissions and economic growth supporting the feedback hypothesis in Portugal.

Law, Ali & Zannah (2016) in their empirical research carried out using ARDL Approach in Nigeria. There findings indicate that energy consumption exhibits positive significant impact on C02 emissions. Similarly, Esso & Keho (2016) used Bounds test, and Granger causality test in Sub-Sahara African Countries from 1971 to 2010. Their findings show that there is a positive and significant long-run relationship between energy consumption, and CO2 emissions in majority of the countries.

Ahmad, Zhoa, Shahbaz, Bano, Zhang, Wang & Liu (2016) employed VECM in India from 1971 to 2014. Their results show that there is a long-run equilibrium relationship between electricity consumption and CO2 emissions. Accordingly, electricity consumption has a positive influence on CO2 emissions in India.

Alege, Adediran, & Ogondipe (2016) used the Johansen maximum likelihood cointegration test in Nigeria from 1970 to 2013. Their findings show that there is a long-run negative relationship between energy consumption and CO2 emissions. However, unidirectional causality running from electricity consumption to economic growth (GDP) per capita and CO2 supporting the conservation hypothesis. They suggested that there is no causality between economic growth (GDP) per capita and CO2 emissions.

Kizilkaya (2017) employed the ARDL bound test to determine the impact of energy consumption on CO2 emissions in Turkey from 1990 to 2014. The findings show that energy consumption exhibits a positive influence on CO2 emissions in the long run.

Another recent study by Gambo, Ishak Ismail & Idris (2018) used ARDL techniques in Nigeria to evaluate the relationship between energy consumption, CO2 emissions, and economic growth. Their results show that there is a positive and significant relationship between energy consumption and economic growth in both short and long run supporting the conservation hypothesis in Nigeria.

Vijay (2018) looking at developing countries which Nigeria is inclusive in terms of electricity generation, stated coal-powered electricity is threaten by environmentalist who have the wrong perception of it causing both environmental air pollution (fine particulate matter and toxic gases) and global warming. Despite this, in most developing countries farming activities, vehicular emissions and coal burning have continued to remain major sources of environmental pollution.

Bello, Solarin, & Yen (2018) employed the cointegration test, VECM and Granger Causality test to investigate the influence of hydroelectricity consumption on the environment in Malaysia from 1971 to 2016. Their findings indicate that hydroelectricity is significant in reducing environmental degradation. Accordingly, there is a unidirectional Granger causality running from hydroelectricity to all forms of environmental degradation.

3.5 The EKC Hypothesis in the Nigerian Context

There are several empirical papers that have sought to investigate the applicability of EKC hypothesis in the Nigerian context. For instance, Omisakin & Olusegun (2009) using the EKC hypothesis to determine the relationship between economic growth and CO2 emissions, reveals the non-existence of long-run relationship between income per capita and CO2 emissions per capita. The findings invalidated the EKC hypothesis since the curve shows a U-shaped and not an inverted U-shaped curve as expected. Instead, it was observed that an initial increase in GDP per capita leads to a decrease in CO2 emissions. However, CO2 emissions start to increase again in the long long-run.

Similarly, Abimbola & Bello (2010) investigated the influence of economic growth (GDP) on energy consumption and CO2 emissions from 1980 to 2008. They used the standard Environmental Kuznets Curve (EKC) method of Grossen & Kreuger, (1995), Holtz & Selden 1995 & Fried & Getzer (2003) which is in log-linear quadratic cubic form. They fail to support the EKC relationship in Nigeria

Furthermore, Akpan & Chucku (2011) adopt Auto Regression Distributed Lag (ARDL) approach and EKC model to test the relationship between economic growth and environmental degradation in Nigeria from 1960 to 2008. Their findings show no support for EKC relationship but an N-shape relationship with a turning point at $77.27

In addition, Muse (2014) employed OLS, ECM and Pairwise granger causality test techniques in Nigeria from 1980 to 2012. Their findings show there is long run relationship between economic growth and energy consumption. Accordingly, there is a bidirectional causality moving between energy consumption economic growths supporting the feedback hypothesis in Nigeria.

More so, Alege & Ogundipe (2015) examine the association between environmental quality and economic growth to find out whether economic growth affects environmental quality in Nigeria. They adopt the Fractional cointegration technique for sample size from 1970 to 2011. Their findings show that development in the short run increases environmental degradation. The study was not able to ascertain a reasonable turning point and the support for the EKC relationship in Nigeria.

Esso & Keho (2016) used Bounds test, and Granger causality test in Sub-Sahara African Countries from 1971 to 2010. Their findings show that there is a positive and significant long-run relationship between energy consumption, economic growth, and CO2 emissions in the majority of the countries. Similarly, their results show that there is a short run causality running from economic growth to CO2 emission in Nigeria, Senegal, Benin, Ghana, and the Democratic Republic of Congo. More so, there is a reverse causality running from CO2 emissions to Economic growth in Nigeria, Gabon, and Togo. There is a unidirectional causality running from economic growth and energy consumption to CO2 emissions supporting the conservation hypothesis.

Aye & Edoja (2017) used the dynamic panel threshold approach to examine the effect of economic growth (GDP) on CO2 emissions covering 51 developing countries from 1971 to 2013. Their findings do not support the EKC relationship because economic growth was discovered to have a negative and positive effect on CO_2 emission in the low and high economic growth regimes, respectively.

A recent study carried out by Adu & Denkyirah (2018) evaluates the validity of the EKC hypothesis in West Africa. There findings show that GDP positively affects CO_2 emissions in the short run but does not negatively influence CO_2 in the long run as assumed by the EKC Hypothesis. This indicates the non-existence of EKC in West Africa, meaning that the inverted-U-shaped curve does not support the relationship between economic growth and environmental quality degradation in the sub-region.

Another recent study by Abdul-Rahim & Sulaiman (2018) employed Recursive ARDL approach in Nigeria from 1971 to 2010. Their findings show that there are positive and significant short-run and long-run relationship between Economic growth and CO_2 emissions supporting the EKC relationship in Nigeria. However, their results indicate that energy consumption and CO_2 emissions are related only in the long run and not in the short run.

In the light of the theoretical and empirical review of the related literature, the majority of the findings clearly indicate the non-support for the EKC hypothesis for the Nigerian economy.

It should be noted that existing studies covered the period until 2012 for explaining the EKC hypothesis and the relationship between environmental quality and economic growth in Nigeria. There are significant changes experienced by the Nigerian Economy which are not captured by existing studies after 2012. Though there is the problem of data collection in most of the developing countries, the present thesis extends the current literature by using considerably up to date series covering the period from 1971 to 2014 to explain the EKC hypothesis and the relationship between environmental emissions and economic growth in Nigeria.

3.6 Federal Republic of Nigeria

The Republic of Nigeria is the largest country in West Africa with a projected population of about 190.9 million people in 2017 as provided by the World Bank. The country is situated on the Gulf of Guinea on the west coastline of Africa between latitudes 3°15’ to 13°30’ N and longitudes 2°59’ to 15°00’ E. It bounded by Cameroon in the South East, Chad in the North East, the Benin Republic in the West and Niger in the North. In addition, it is one of the largest countries in Africa with a land area of 923 768 km2 and a sum borderline length of 4900 km, together with 853 km of coastline.

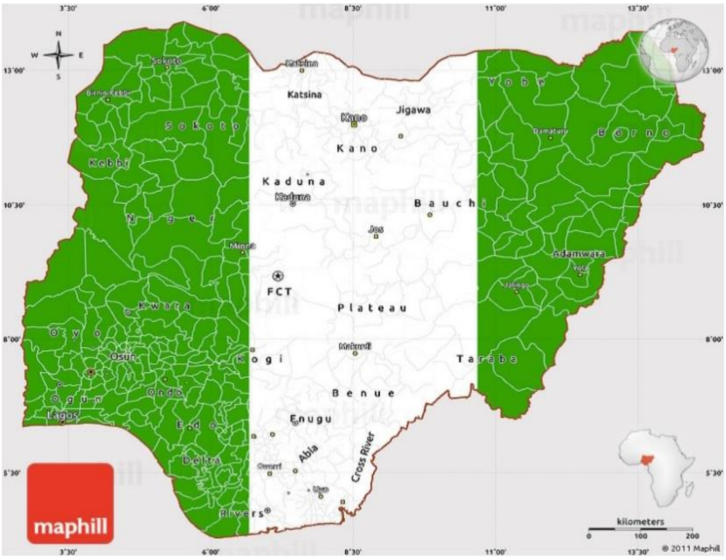

Image 1: Map of Nigeria.

(http://maps.maphill.com/nigeria/simple-maps/flag-map/flag-simple-map-of-nigeria.jpg Retrieved 4 April, 2019)

Nigeria is situated first and foremost within the lowland moist tropical area. It is by and large it is characterized by a high heat periods roughly through the year. From the southern part, the average highest temperature stood at 32oC whereas in the northern part of the country is 41oC. Furthermore, 27oC is the average temperature of the country in the nonexistence of altitudinal adjustments. In recent times, there has been a broad-spectrum rise in temperature all over the country. Nigeria’s climate moves from an extremely damp coastal area with yearly precipitation higher than 3,500 mm to the

Sahel area in the north-western and north-eastern regions, with yearly precipitation of lower than 600 mm.

The country is legitimately an independent secular nation. Nigeria comprises 36 states and the Federal Capital Territory (FCT), Abuja. The States, as well as the FCT, are further fractionalized into 774 Local Government Areas/Area Councils for easy control and organization at the grassroots level. For political and development objectives, the 36 States are classified into 6 geopolitical regions. The states are shown in Image 1. The Constitution that fundamentally holds the country offers for a presidential system of government. Accordingly, Executive, Legislature and Judiciary exist. As an ancillary, the Nigerian Constitution gives the legitimacy for the existence and functioning 3 levels of government (Federal, State, and Local tiers).

Nigeria was colonized by Britain in 1901 but gained its independence in 1961. It has been under military rule since its independence until 1999 when power was shifted to a democratically elected government. Nigeria is blessed with numerous natural resources which include crude oil, iron, barite, gypsum, kaolin, marble, tantalite, coach coal just to mention but a few. The economy could have been better than what it is today if most of these resources were properly utilized.

3.7 The Nigerian Economy

The Nigerian economy has continued to depend largely on petroleum since its independence. Although, agriculture was the mainstay of the economy before the discovery of crude oil in late 1960. The agricultural sector suffered relegation since the discovery of oil and gas. Cash crops such as cotton, groundnuts palm oil, and cocoa were no longer important as major sources of exports revenue. Petroleum has become the main source of government revenue and foreign exchange. The petroleum industry has increased the level of the Nigerian economy by contributing the largest portion of the GDP growth and accounting for huge revenue and foreign exchange earnings in the past decades (Umaru & Zubairu, 2012).

The Nigerian economy is a mixed market economic system where the factors of production are control by both the government and the private market. The prices of goods and services in a mixed economy are not always determined by the forces of demand and supply but are fixed by law in some cases to allow economic growth and development (Owolabi, 2018). Therefore, both the government and the private sector (consumers and producers) make decisions based on the pricing system. The free interaction of government, consumers and producers facilitate a workable economy. In fact, is an economy that gives freedom to the consumers to decide on what and where to spend their money, the producers to decide on what to produce, how to produce in other to maximize profit. It is the responsibility of the government at all levels to pursue and guarantee public security and safety, provide the enabling environment, infrastructures and essential services that could better be performed by the public sector rather than the private sector (Ramsey, 1991).

The main sector of the Nigerian economy is the oil industry. Therefore a negative shift in oil price will have a negative influence on the Nigerian economy. For instance, the sudden decline in oil price as announced by the OPEC could have led to the negative GDP of -1.6% in 2016. Nigeria remains the Africa's largest oil producer and the World's 6^{th} oil producing country today with a maximum crude oil production capacity of 2.5 million barrels daily (NNPC, 2018).

Apart from the oil sector, there are some other vital sectors which include the mining industry and agriculture. The major mining activities include coal, tin cassiterite, bauxite, iron ore, gold gypsum, and columbite while cassiterite and concomitant columbite mineral is and extracted and manufactured by an open method.

In Nigeria, the majority of the population engage in agricultural activities which involve the production of food crops such as yams, sweet potatoes, corn, cassava, rice and so on. Other agricultural products include cacao beans, natural rubber, cotton, peanuts, and soya beans. However, it is evident that since the mid-1980s the agricultural sector has continued to suffer set back due to oil discovery in Nigeria.

Majority of the rural population have migrated to the urban cities in search of greener pastures (Elizabeth, 2019). The Nigerian government has embarked on several economic reforms due to the stagnation and poor performance of the economy over the years. Some of the reforms aimed at recovering and sustaining economic growth include the Structural Adjustment Programme (SAP) of 1986, National Economic Empowerment and Development Strategy (NEEDS) of 2003, The Seven-Point Agenda of 2009, Transformation Agenda of 2011 and The Government Economic Recovery and Growth Plan of 2016. Other recent programmes include N-power, Poverty Alleviation Program, Subsidy Investment Program and others put in place to empower the youths and reduce the alarming rate of unemployment in Nigeria (Okonjo-Iweala & Kwaako, 2007)

3.8 The Economic Outlook of Nigeria

The Nigerian economy is characterized by a series of fluctuations right from the 1970s to date. In the 1970s, the economy depends largely on the oil sector which appears to have contributed the largest portion of the GDP growth of Nigeria. The GDP of 25% was recorded in 1971 indicating a remarkable growth due to oil price boom. However, by 1980s the GDP had gone down to -15% due to falling in oil output and price as announced by OPEC. The GDP continued to experience a downward slope until in the 1990s when oil price started to increase. By 1990 the GDP had gone to 8.9% perhaps as a result of the increase in oil price and the economic reforms implemented by the Federal Government of Nigeria. According to Okunrounmu 1993, SAP has significantly improved the economic growth after the slow growth rates of 2.2 % experienced in 1986. The real GDP at the 1984 factor cost had gone up to 7.0% in 1988. The economy also experiences another growth in 2000 through 2002. The real GDP rate rose to

3.8% in relation to 1.8% in 1998 and 2.8% in 1999. This growth increase was due to the sharp oil price rise from $18 per barrel in 1999 to $28 per barrel in 2000.

As a result, the government of Nigeria also increases its spending which stimulate the economy with an increase in the real GDP to 3.8% in 2000 and 15% in 2002 (OECD/AFDB, 2002). This remains the highest growth recorded. Despite the global financial crisis of 2007, Nigeria growth rate was 3.82% probably due to the bank reforms of 2004 which involve the consolidation and recapitalization of the banking sector. Since this period, GDP has continued to fluctuate leading to the economic recession of 2016 with a negative GDP of -1.6%. The negative economic growth could have occurred due to another oil price slump of 2016. The oil price had gone down from $54.4 per barrel in 2015 to $44.54 per barrel in 2016 (YCHARTS, 2018).

The economy started recovering from the recession as oil price shut up again to $54.3 per barrel in 2017. Following this increment, GDP grew slightly from -1.6. On the other hand, the service and manufacturing sector experienced a contracted growth of 2.7 % and 2.9 % in the second and third quarter of 2017 (Afrinvest West Africa, 2017). However, the GDP increase to 2.4% on year-The Nigerian economy is characterized by a series of fluctuations right from the 1970s to date. In the 1970s, the economy depends largely on the oil sector which appears to have contributed the largest portion of the GDP growth of Nigeria. The GDP of 25% was recorded in 1971 indicating a remarkable growth due to the oil price boom. However, by 1980s the GDP had gone down to -15% due to falling in oil output and price as announced by OPEC.

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The general outlook of the economy shows that the Nigerian Economy had experienced remarkable real GDP growth of 25% in 1971, 11.77% in 1990 and 15.33% in 2002. However, the economy had to continue to suffer depression from 2002 to date.

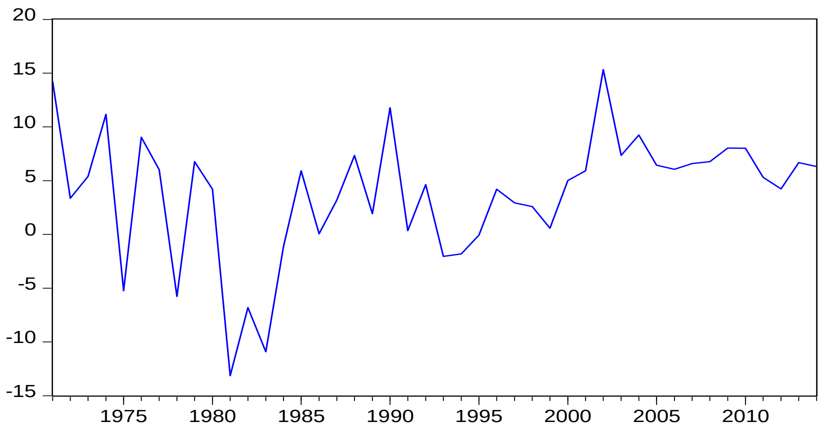

Figure 3: Percent Economic Growth in Nigeria (GDP)

(Computation from EView's 10 versions)

3.9 Electricity consumption per capita (Khw) in Nigeria

Nigeria is an energy-dependent country. The annual electricity generated in kilowatt-hours is not sufficient and efficient to meet up with its demand for production and other economic activities. World Bank statistic shows that electricity consumption per capita in 2012 was 156.733 (Kwh), 2013 was 142.68 (Kwh) and 144.48 (kWh per capita) in 2014 which signifies a drop of7.82 %. Perhaps this could post an important effect on the GDP growth and performance of the economy of Nigeria (WDI, 2019).

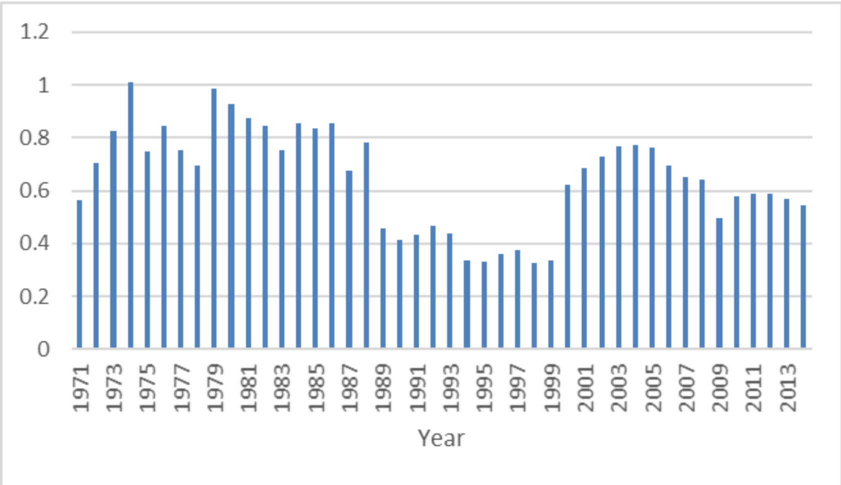

Figure 4 Graph of electricity consumption per capita in Nigeria

(Computation from Excel)

3.10 CO_2 emissions per capita (metric tons) in Nigeria

In Nigeria, it has been observed that CO_2 emission per capita measured in metric tons increases alongside economic growth which is measured by income per capita. For instance, in 2005 the GDP per capita was 3.72 and CO_2 emissions were 0.763, per capita. In 2014, GDP per capita drops to 3.52 and CO_2 per capita emissions also dropped to 0.55. Similarly, when electricity consumption decreased by 8% from 2012 to 2014, CO_2 emissions also dropped by 8% (WDI, 2019). This pattern of changes in GDP growth per capita and emissions of CO_2per capita are interesting and require the examination of their relationship.

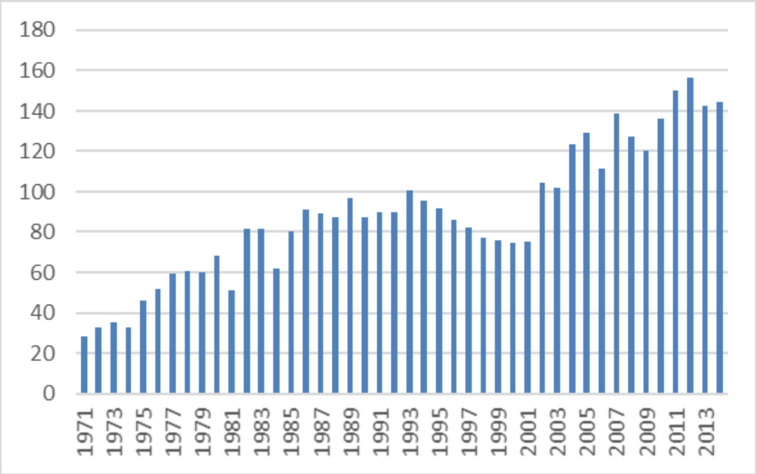

Figure 5: Graph of CO_2 emissions of Nigeria.

(Computation from Excel)

The Nigerian real GDP growth rate signifies the sluggish growth nature of the economy over the years. The observed similarity in the growth trend of GDP growth per capita and Electricity usage per capita (kWh) and CO_2 emissions indicate the dependent of Nigeria on energy for its economic activities. However, electricity provided is inadequate compared to the population of about 190 million people. The limited supply of electricity has made many people change from the use of electricity to fossils fuel and gas flaring as alternative sources of energy. The increasing demand for fossils fuel and gas by the people has led to increasing deterioration of the environment.

3.11 An overview of Energy Sources and C02 emissions by sector for Nigeria

As contained in First Biennial Updated Report (BUR1, 2018), Nigeria's GHG emissions increased 25% between 1990 and 2014, averaging 1% annually, while GDP grew 245%, averaging 5.5% annually. even though Nigeria tends to more rapidly than GHG emissions, in 2014, the country's emissions comparative to GDP were 1.6 times the world average, signifying prospect for greater improvement.

3.11.1 Energy Sector

Oil and natural gas as well as biomass make up the most important sources of power for the Nigerian economy. There is, nevertheless, a momentous endeavour towards harnessing the huge potentials presented from other sources of energy such as solar and wind

3.11.2 Energy Oil and natural gas

The Nigerian Oil and natural gas sector is reported to be the second major confirmed crude oil reserves on the African continent based on the Abstract of Statistics 2016 (NBS, 2017) contained in the National Bureau of Statistics. The total reserves capacity is shown to be 37,448.25 million barrels as at 2014. For the same period, the Nigeria makes total production of approximately 699,486 barrels of unfinished/crude oil but it exported 773,833 barrels. The Southern part of the countryside is the region where crude oil is extracted, particularly in the coastal part of Niger Delta region in the Gulf of Guinea.

Present exploration endeavours are typically concentrated in the subterranean as well as ultra-deep coastal areas, with a number of enterprises around the Lake Chad Basin situated in the far north-eastern region of the geographical space of country.

Generally, the exploitation of oil and gas in the over the last forty years has caused enormous injection of hydrocarbon-related substances into the climate and substantial ecological harms. This has made oil and gas sector an essential sector in the conversation of GHG-motivated climatic change, its cost, and the necessity for lessening and adjustment relative to this sector. It should be noted that Nigeria is among the principal producers of natural gas in the continent. At the moment, production is estimated to grow twofold between 2015 and 2030, rising approximately to 400b m^3 annually.

Confirmed restorable reserves of gas in Nigeria in 2011 stood at 5,110b m^3. Up to date production of 29b m^3, is projected to last over a century (WEC, 2013; BUR1, 2018).

One important that should not be forgotten is the considerable quantity of the country's total natural gas production that is lost as result of gas flaring. This arises as result of the fact that a number of Nigeria's oil wells do not have that infrastructural capacity desirable to confine the natural gas created alongside oil, identified as allied gas. It is on record that about 10.73b m^3 of natural was lost due to gas flaring in 2014. Putting it differently, about 12% of total production is lost to gas burning and it is ranked as the world's fifth-highest gas flaring nation, contributing to about 8% of the gross sum of burned worldwide in 2014 (WEC, 2013; BUR1, 2018).

Nonetheless, it is remarkable that whereas country still flares a considerable fraction of its total natural gas n (12% as at 2014), the quantity of natural gas destroyed has reduced by more than 50% over the past 10 years BUR1, 2018). At present, the country positioned as the fifth-highest natural gas flaring nation, downward from the number two position it was in 2011.

3.11.3 Biomass

It is on record that Nigeria is the 3rd overall principal producer of bio energy in the entire global landscape following People's Republic China and India, correspondingly. As at 2010, the proportion of bioenergy of total principal energy supply was over 80% (WEC, 2013; BUR1, 2018). By 2011, the country was ranked as regarded as one of the leading producers of fuel wood alongside with India, People's Republic China, Brazil and Ethiopia. The components of biomass in Nigeria may include crop deposits, feed (grasses together with shrubs), and the wastes from animal waste and waste originating from the forest, public as well as industrial activities, as well as, marine biomass. Agricultural crops including sugary sorghum, corn and sugarcane are the largest part that contributes to feedstock towards producing biofuel. The projected production of animal waste for Nigeria is roughly 227,500 tons (BUR1, 2018). Given that 1kg of brand new animal waste creates approximately 0.03m^3 of biogas, the Nigerian economy is said to create roughly 6.8 million m^3 of biogas daily from the waste of animals (BUR1, 2018).

3.11.4 Other energy sources

i. Coal: This is one of the important sources of energy in Nigeria. As at 2011, the country had about 21 million tons of confirmed restorable bituminous coal deposits, this includes anthracite (BUR1, 2018). The country ranked among the five (5) top economies in the African continent based on reserves.

ii. Wind: This is however not a key source of energy for the Nigerian economy. As at 2011, the country mere had about 2MW of fully mounted or installed capacity (BUR1, 2018).

iii. Nuclear: The Plan of Country is to possess approximately 1,000MWeinstalled of nuclear energy before 2020 and approximately 4,000MWe in 2027. The country has drafted a plan for the safe, sound and sustainable administration of radioactive waste-related products and depleted nuclear fuel has as well been arranged. The strategy has to do with an option for the use once repatriation of used up fuel is not feasible (BUR1, 2018).

iv. Geothermal: existing study reveals that more examinations are required, nevertheless recent suggestions point toward the potential existence of geothermal energy in Nigeria (Zira, 2013; BUR1, 2018) through the geothermal slope of the Bain Anambra state straddling from 2.5 to 4.90c /100m as well as the Basin of Bida from 2 to 2.50c/100m.

v. Solar: The advantageous geographical position of the country in which it situated in the interior of high temperate region and consequently possesses massive solar energy potentials. This source of is comparatively well dispersed with a mean of about 19.8MJm-2day and mean temperature of hours of 6hours per day (REN21, 2014). REN21 further showed that when solar collectors were employed to cover up 1% of Nigeria’s land space, there is the possibility for the country produce about 1850 x103GWh of electricity annually. This amount is more than hundred times the present grid of electrical energy use in the nation. However, this prospective is until now not suitably exploited to further reduce the dependence on C02 increasing sources of energy. The country has a projected 20MW only of fully solar energy installed

vi. Hydro: The country is convincingly gifted with great rivers and little natural falls. Undersized rivers as well as streams in addition subsist inside the current part of the Nigeria's 11 River Basin Authorities, a few of which preserve lowest discharges throughout the year. Based on the outcome of an investigation conducted in 12 states as well as 4 river basins, more than 278 fallow small hydropower (SHP) locations with a sum potential of about 734.3MW was clearly revealed. On the other hand, SHP prospective locations subsist in practically in every part of country with a projected overall capacity of 3,500MW. It was shown that the country has potential clean energy sources alongside her several river systems, a sum of 70 micro dams, 126 mini dams as well as 86 small sites are revealed.

3.12. The Manufacturing Sector $C0_2$ (million metric tons)

CO2 emissions from industrial manufacturing sector in Nigeria stood at 43.2 in 2011 accord

ing to the WDI, collected from formally accepted sources. CO2 emissions arising from the industrial production as well as construction activities contain the emissions from burning of fuels in manufacturing industries. The IPCC Source/Sink Class 1 A2 incorporates these toxics. Nevertheless; in the 1996 IPCC guiding principle; the IPCC Class in addition incorporates toxic substances from manufacturing auto producers that produce electrical energy as well as/or heat.

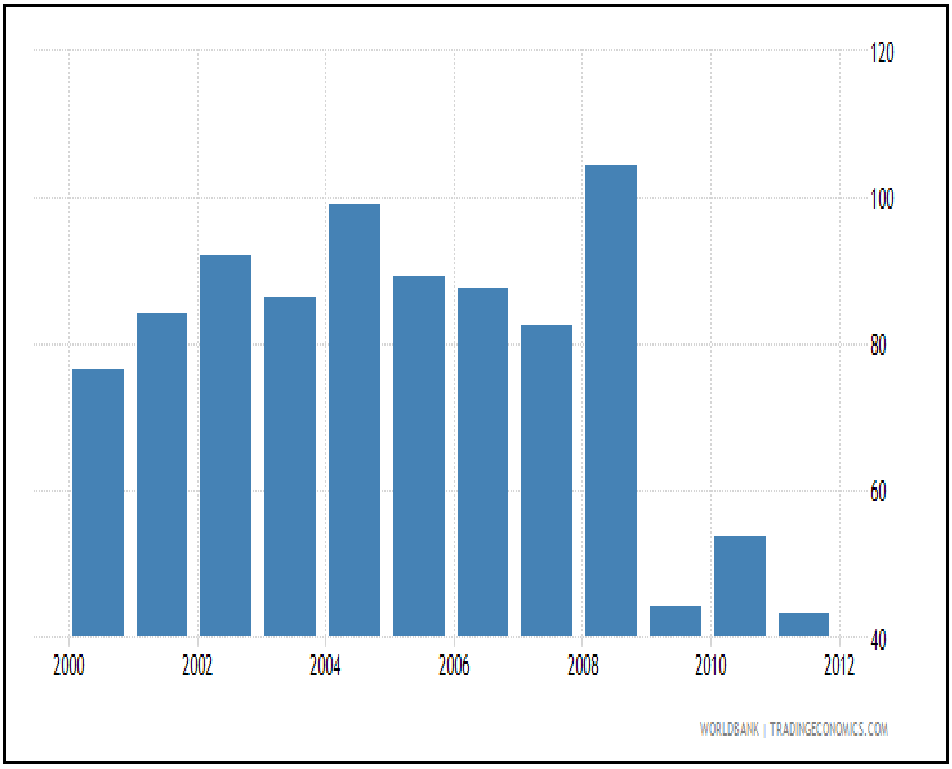

Figure 6: Manufacturing Sector $C0_2$ (million metric tons)

(*Sources: WorldBank/Trading Economics, 2019)*

The International Energy Agency statistics are not assembled in a manner that permits the energy use to be divided based on explicit final-use and as a result; auto producers are given as a detached entry (Not allocated Auto producers). The industrial/Manufacturing sector furthermore comprises emissions from coke inputs into discharge furnaces.

3.12.1 Residential Sector

CO2 emissions emanating from residential buildings and business-related and public services (million metric tons) stood at 23.3 in 2011 according to the WDI, collected from formally conventional sources.

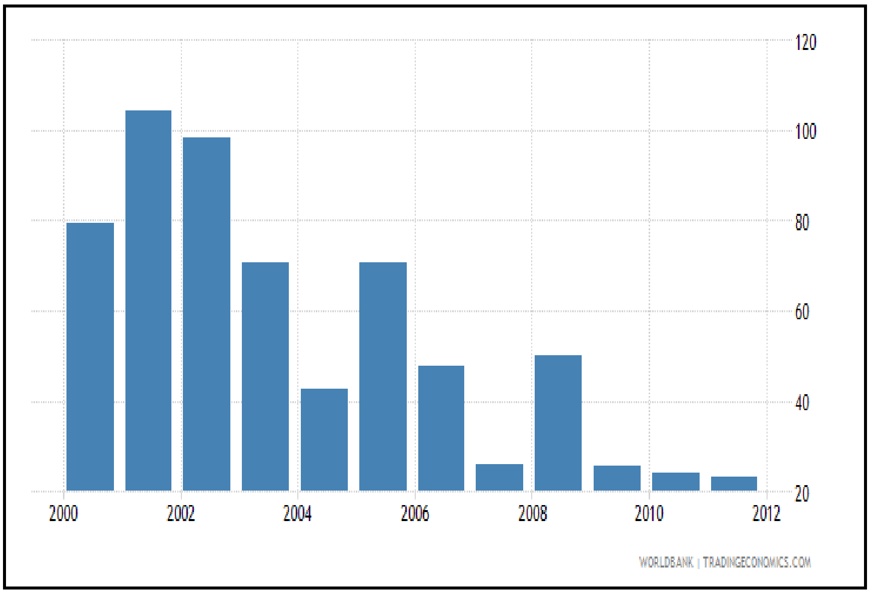

Figure 7: Residential Sector CO2 (millions metric tons)

(Sources WorldBank/Trading Economics, 2019)

The emissions from corresponds to IPCC Source/Sink Category 1 A 4b. Accordingly, the businesses as well as municipal services comprises emissions from all enterprises of ISIC Categories 41, 50-52, 55, 63-67, 70-75, 80, 85, 90-93.

3.13. Agricultural Sector, Forestry and Other Land Use (AFOLU)

Activities that occur in the AFOLU sector are amongst the major drivers of C02 emission in the country. This qualifies the sector to be a chief category in the understanding greenhouse emissions. Approximately 78% of the whole land area of the Nigeria is under agricultural sector. Out of these, about 48.0% comprise arable lands; 42.8% are for lasting meadows and pastures and the rest 9.2% are used for crops cultivation. This sector of the economy employs high number of people than rest on the sectors and contributed about 24.4% of GDP by the end of 2016. The production of agricultural cops is by far the most important constituent of the agriculture sector, accounting for about 89.7% of gross GDP. Climate change causes a danger to the country's agricultural output. The World Bank lately predicted an up to 30%

fall in the country's crop output due to unpredictable rainfall and high temperatures.

3.14 Climate Change Mitigation Targets and Plans in Nigeria

Nigeria has promised to categorically lessen environmental pollution by 20% in 2030, relative to business as usual (BAU) emission intensities. The country thrives to realize this objective by enhancing energy efficiency by 20%, providing 13 GW of C02 reducing equipment to countryside communities that are presently disconnected to the national electricity grid, and by stopping gas flaring. The main indicators towards achieving this superior intended goal has to do with rising energy efficiency and drastically decreasing the utilization of generators, at the same time as giving access to energy for each and every one in the country. The overall measures of pollution mitigation are: stopping the flaring of natural gas in 2030, realizing off-grid solar PV production/generation of roughly 13 GW, the use environmentally friendly gas generators, realizing a 2% annual boost in power efficiency (30% in 2030), improving the mode of transport which has to do with moving away from automobiles to buses, enhancing the electrical energy grid, adopting climate smart agriculture, and reforestation of the Nigerian economy.

Accordingly, the country has itemized 6 projects (national/regional) are scheduled under the Programme of Activities (POA). Below are the projects:

i. Cable driven Public Mass Transit Projects in the country
ii. Delivery of efficient cooking stoves in Sub-Saharan Africa
iii. Energy efficiency of the country's housing lighting stock via the supply of about 40m compact fluorescent lamps (CFLs) to family units linked to the grid African better cooking stoves programme of enterprises
iv. POA for the lessening of greenhouse pollutants from non-renewable energy for cooking at family unit level.
v. Supply of energy-efficient enhanced cooking stoves in Nigeria
vi. POA for superior cooking stoves for Nigeria (BUR1, 2018).

CHAPTER 4

DATA AND METHODOLOGY

4.1 Introduction

This chapter theoretically modelled the relationship between the variables. It proceeded to specify the econometric methods used for the analysis.

4.2 Sample and Data Description

Carrying out empirical research of this nature requires the collection of relevant data from appropriate secondary sources. In general terms, before investigating the relationship, there is the necessity to select suitable proxy measures to represent the consumption of electrical energy as well as Per Capita GDP growth. It should be noted that diverse proxy variable selection ranging from monthly, quarterly to annually frequently lead to variations in research outcomes. On the whole, scholars generally select electricity consumption (EC) and GDP to measure the intensity of electricity consumption and economic growth (Arouri et al. 2012 & Alege et al. 2016).

Accordingly, yearly data were parsimoniously gathered from World Bank Group (2019) which covers the period spanning 1971 to 2014. The world supplies rich and reliable statistics relating to various aspects and sectors of economies around the globe. In the context of the present thesis, variables including EC per capita, GDP per capita and CO_2 emissions per capita were carefully gathered to answer the research questions as given in Chapter 1 sub section 1.3.

The choice of annual data instead other series given in other time periods is due to the nature of the data availability. Annual data, in this case, is appropriate since it allows for estimations that focuses on changes that might have taken place during the year and provide a possible strategy that measures possible responses to government policy. Moreover, the majority of the studies used annual data to carry out their statistical analysis.

- **Carbon dioxide (CO2)**

CO2 is a physically originating gaseous elements predetermined by photosynthesis into natural matter. It is side-effect of fossil fuel incineration and biomass burning; it is also produced as a result of land usage variations and other manufacturing processes. It is the most important anthropogenic greenhouse gas which tends to affect the Earth's radiative stability. It is the reference gas against which other greenhouse gaseous elements are calculated, therefore, possessing a Global Warming Potential.

- **GDP per Capita**

GDP per capita simply refers to the GDP divided by midyear number of the people. Note that GDP shows the summation of total value added by all locally domiciled productive agents in the economy. This value also includes taxes on products less any subsidies which is not incorporated in the value of the products. Based on the backdrop of a stable GDP growth, improvement in the structure of income structure provides good conditions for a stable development of the economy. Consequently, income per capita is correct proxy of economic growth and development of a country.

- **Electricity Consumption**

Electric power consumption essentially measures the creation of energy facilities and accumulated heat and power plants minus conduction, delivery, and conversion losses and individual use by heat and power plants/facilities. It is also referred to as the sum total of the public electricity use. It is principally separated into the whole industrial electricity use and metropolitan and countryside residential livelihood electrical energy. The sum total of industrial electricity use has to with the electricity use of the primary, secondary as well as tertiary industrial spaces. Lopsided industrial compositions exert significant effect on the connection involving electricity use, C02 and GDP growth.

4.3 Methodology

The Augmented Dicky-Fuller test (ADF) and Philip-Perron test (PP) were used to test the unit roots of the variables. The ADF and PP are the widely and commonly used methods for checking the properties of times series or stationarity. The ADF and PP are used complimentarily, but they are different from each other in terms of dealing with the issues of serial correlation and heteroscedasticity in the errors. While the ADF tests make use of a parametric auto regression towards approximating the ARMA construction of the errors in regression analysis, the PP technique pays no attention to any autocorrelation in the analysis.

Johansen Cointegration was used to investigate the cointegration between GDP growth, use of electricity and emissions of CO_2, if they are all found to be stationary after conversion to the first difference or order I(1).

In order to further add more clarity on the existence or otherwise of long run correlation connecting the series, the study also conducts the Gregory Hansen cointegration test. This method is higher and suitable than the traditional approach given that it permits for shift in regime over the long-term period following any structural innovation/shock. The last technique is basically informed by the outcome of the preceding approaches. Hence, Toda Yamamoto Non-Granger Causality was carried out to examine the causal among the series.

4.4 Theoretical Model

The research is based on the EKC model, which is written as:

$$CO_2 = f(EC, GDP) \tag{1.1}$$

Where, emissions of $CO2$ is the function of electricity usage (EC) and economic growth (GDP).

Therefore, the functional relationship in equation (1.1) can be written in a linear form as seen below.

$$CO2_t = \beta_0 + \beta_1 EC_t + \beta_2 GDP_t + \varepsilon_t \tag{1.2}$$

Where;

$CO2_t$ = is emissions of carbon dioxide per capita (metric tons),

EC_t = is electricity usage per capita (KWh),

GDP_t = is the per capita gross domestic product (constant US$),

ε_t = is the error term which we sort to minimize,

β_0 is the constant, and

β_1 and β_2 in the equation represent the coefficients of EC_t and GDP_t respectively in the model.

4.4.1 Unit Root Test

To find out the level of integration of the series, ADF and PP methods stationarity test are applied in this thesis. ADF test for the null hypothesis of unit root present in a time series sample while PP builds on the ADF null hypothesis. However, the PP is the modification of the ADF which is robust to correct the problems of autocorrelations and heteroscedasticity in the error term εt (Dickey and Fuller 1981; Phillip & Perron 1988).

$$\Delta y_t = \mu + \alpha y_{t-1} + \sum_{i=1}^{p} \beta j \Delta y_{t-1} + \varepsilon_t \tag{1.3}$$

Where;

y_t = is the variable;

μ = intercept;

t = time trend;

p = largest lag length

ε_t = error term.

Δy_t: Under the null hypothesis is 1(0) indicating that α = 0.

The ADF and PP unit root test procedures are very important in the lag length specification. This thesis employed the Automatic lag length selection by Swartz Information Criteria (SIC) and Newey-West Bandwidth (Bartlett-Kernel) for ADF and PP unit root test respectively. The SIC and New-West Bandwidth method of lag length selection is more appropriate considering the small sample size involved in this study (Ivanov & Kilian, 2005). The ADF and PP hypothesis to test for α is as follow:

H_0: α = 0 (unit root)

P = 0 (non-stationary of the time series)

H_1: α ≠0 (no unit root) P< 1 (stationary of the time series)

Rejecting the Ho of non-stationary is an indication that the coefficient of Y is not zero. Meaning that series are stationary at I (0). But if the coefficient of Y is zero, the null hypothesis cannot be rejected. However, accepting the null hypothesis implies that series are non-station at the level. But if series are tested at first difference and the coefficient is different from zero then the hypothesis of series are non-stationary is rejected meaning that series are stationary at I (I). The ADF and PP t-statistics is used to test the significance of the coefficient of yt-1 in the regression equation (1.3) above

4.5 Econometric Methodologies

4.5.1 Johansen Cointegration

Here, the trace and maximum eigenvalue test is used to examine the number of cointegrating ranks at 0.05 critical level. This study uses the Osterholm &

Hjalmarsson (2007) method of Johansen cointegration equation which is given as follows: Vector auto regression (VAR) order of *P:*

$$y_t = \mu + A1y_{t-1} + APy_{t-p} + \varepsilon_t \qquad (1.4)$$

Where;

y_t = vector of order I (1)

$A1$ = is the coefficient matrix for each lag.

ε_t = vector of innovation with zero mean

P =is the assumed common non-stationary underlying process I (1)

Equation (5) could better be written as:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma i \Delta yt - i + \varepsilon t \qquad (1.5)$$

$$\text{Where } \Pi = \sum_{i=1}^{p} Ai - I \text{ and } \Gamma = -\sum_{j=i+1}^{p} Aj \qquad (1.6)$$

The trace and maximum eigenvalue equation to test the hypothesis for the presence of cointegration of the series are written as follows:

Hypothesis:

H_0: r = 0 (no cointegration of series at all)

H_1: r = > 0 (cointegration of the series)

$$\text{Trace } j = -\Gamma \sum_{i=r+1}^{n} 1n(1-\lambda i) \qquad (1.7)$$

Maximum eigenvalue j = Γ (1n (1-λ_{r-1}) (1.8)

The trace test examined the null hypothesis (H_0) of r cointegrating vectors compared to the alternative hypothesis (H_1) of n cointegrating vectors.

The Maximum eigenvalue test, on the other hand, examined the H_0 hypothesis of r cointegrating vectors against the H_1 hypothesis of r + 1 cointegrating vectors.

4.5.2 Gregory Hansen Cointegration

This method is higher and suitable than the traditional methods of cointegration given that it permits for a shift in regime over the long-term period following any structural innovation/shock (Yavuz, 2014). This makes it different from the Johansen method of cointegration. GH is mostly used where long run relationship is not found using the traditional method of cointegration. The problem of the traditional methods in the presence of structural break is what the GH seeks to address. Breaks in the data may lead to spurious unit root behavior in the cointegration correlation. This makes it difficult to reject the null hypothesis of no cointegration or long-run correlation between the variables. Similarly, the GH method prevents the issues of separating a regime shift from a stable cointegrating correlation. While the null hypothesis permits the inclusion of stable cointegrating correlation it equally permits for a breaking long-run correlation in the null hypothesis (Gregory and Hansen, 1996). The specification of the model at level shift is given as:

$$y_{1t} = \mu_i + \mu_2\varphi_1 + \alpha^T y_{2t-1} + e_t \qquad (1.9)$$

Where,

y_{1t}= actual value,

y_{2t}= is an m vector of series integrated of order (I/1)

e_t = is (I/0)

The entities μ and α captures the m-dimensional hyperplane that the vector process y_t= ($y_{1t}y_{2t}$)

4.5.3 Toda-Yamamoto Granger Non Causality Test

To examine the direction of causality between electricity usage, GDP growth, and CO_2 emission, the study employed the Toda-Yamamoto Granger non-causality by Toda and Yamamoto (1995).

This method has an advantage over the traditional Granger causality methods because it is carried out regardless of whether the variables are integrated at I(0) or I(1) and whether they are cointegrated or not.

The fully modified Wald test is used to determine the restrictions of the parameters on the Var (p) model estimated as Var (p + dmax). Where p is the lag length and dmax is the maximum order of integration of the variables. The optimal lag length k, is 1 selected based on Akaike Information Criteria and Swartz Information criteria because of their ability to deal with both risks of overfitting and under fitting (Bumham & Anderson, 2002). The dmax is 1 because all the variables are integrated of the same order I(1). However, if electricity usage, GDP growth, and emissions of CO_2 have a stochastic common trend then they will have a causal relationship.

$$Yt = \beta_0 + \sum_{j=1}^{k} \beta 1iYt - i + \sum_{j=k+1}^{p-dmax} \beta 1jYt - j + \sum_{j=1}^{k} \mu 1iXt - i + \sum_{j=k+1}^{p-dmax} \mu 1jXt - j + \varepsilon t \quad (1.9)$$

$$Xt = \beta_0 + \sum_{j=1}^{k} \beta 1iYt - i + \sum_{j=k+1}^{p-dmax} \beta 1jYt - j + \sum_{j=1}^{k} \mu 1iXt - i + \sum_{j=k+1}^{p-dmax} \mu 1jXt - j + \varepsilon t \quad (1.10)$$

The null hypothesis in the regression is that Y(t) does not Granger-cause X1(t) and X1(t) Does not Ganger cause Y(t)

Testing H_o : $\beta_1 = \beta_2 = \beta_3 = - - - = \beta p = 0$ against H_1, Not H_0, meaning that X cannot granger cause Y

Testing H_0: $d1 = d2 = d3 = ... = dp = 0$ against H1, Not H_0, meaning that Y cannot granger cause X

H_1 : $\beta_j \neq 0$ meaning that at least one parameter is not equal to zero.

CHAPTER 5

DATA ANALYSIS

5.1 Introduction

At this point, the empirical analysis is carried out starting with preliminary investigation on the statistical properties of the variables. The ADF, PP and KPSS as well as Structural Break unit root tests are given in this section. Similarly, diagnostic test are also conducted and present in this table. Furthermore, the empirical analysis using Johansen and Gregory Hansen as well as Toda Yamamoto Granger Non-causality are carried out and presented in this section.

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Table 5.1: Augmented Dickey Fuller and Phillip Perron test

Panel A ADF Unit Root Test				
Variables	**None**	**Intercept**	**Intercept and trend**	**First difference**
CO_2	-0.5682	-2.0146	-2.4868	-7.7037***
EC	1.4764	-1.2937	-3.0481	-8.8377***
GDP	0.7293	-0.0716	0.9861	-2.9769**
Panel B. PP Unit Root Test				
Variables	**None**	**Intercept**	**Intercept and trend**	**First difference**
CO_2	-0.5209	-2.0225	-2.6024	-7.7037***
EC	1.5071	-1.0897	-3.0883	-9.2506***
GDP	0.6288	-0.3169	-0.2221	-5.0455***

Note:
*CO2 denotes CO_2 emissions per capita; EC represents electricity consumption per capita; GDP is the gross domestic product per capita. ADF and PP automatic lag length selection of SIC and Newey-West Bandwidth (Bartlett-Kernel) were used. ***, **and * indicate the rejection of the null hypothesis at alpha 1%, 5% and 10% significant level (computed from Eviews 10. Version).*

The ADF and PP results of stationarity is presented in Table 5.1 as seen above. The ADF test findings in panel A demonstrates that the t-statistics of CO2 of -0.5682, -2.0146 and 2.4868, EC 1.4764, -1.2937 and -3.0481 and GDP 0.7298, -0.0716 and 0.9861 are greater than the critical values at 0.05 level of significance. Therefore, the null hypothesis of the series are not stationary at level form cannot be rejected. The inability of the study to reject the null hypothesis implies that all the series are not stationary at I(0). CO2 per capita, EC per capita and GDP per capita become Stationary when converted to the first difference at 1%, 1% and 5% significant level respectively. For instance, the t-statistics and corresponding p-values of CO2 (-7.7037), EC (-8.8377) and GDP (2.9769) are less than the 0.01, 0.05 level of significance. Therefore, the study rejects the null hypothesis that the series are having unit at first difference. Rejecting the null hypothesis signify that all the series are I (1).

The PP result presented in the same Table 5.1 in panel B confirms that C02, EC, and GDP are not stationary at level. The t-statistic and the corresponding P-value of C02 -0.5209, -2.0225 and -2.6024, EC 1.5071, -1.0897 and -3.0883, GDP 0.61288, -0.2221 are all greater than the 0.05 level of significance. Therefore, the study cannot reject the null hypothesis that vectors are not stationary at level. Accepting the null hypothesis implies that vectors are not stationary at I (0). However, the variables attend stationarity when converted to first difference considering the t-statistic of C02 (-7.7037), EC (-9.2508) and GDP (-5.0455) less than the 0.05 level of significance. Rejecting the null hypothesis signify that the variables are stationary at first difference. Based on this study conclude that all the variables are stationary at the I(1) given by both the ADF and PP unit root test.

In addition, the Kwiatkowski, Philips, Schmidt & Shin (KPSS) test is conducted to complement the above ADF and PP tests. Here, the null hypothesis of data are stationary and the alternative hypothesis assumed that data have unit root (Kwiatkowski, Phillips, Schmidt & Shin, 1992). The test result is presented in Table 5.2 below:

Table 5.2: Kwiatkowski, Philips, Schmidt & Shin (KPSS) unit root test

	At level		First difference
Variables	Test 1	Test 2	Test 3
C02	0.2998***	0.1115***	0.1115***
EC	0.7553	0.0967***	0.0728***
GDP	0.2318***	0.2031**	0.4317*
	0.01	0.05	0.1
Test 1: intercept	0.739000	0.463000	0.347000
Test 2: intercept & Trend	0.216000	0.146000	0.119000
Test 3: first difference	0.739000	0.463000	0.347000

*Note: ***, **,* denotes acceptance of null hypothesis at alpha 1%, 5% and 10% level of significance*.

The results from KPSS shows that C02 emissions and GDP became stationary at intercept while EC becomes stationary at intercept and trend. For instance, the LM statistic of 0.2998 for C02 and 0.2318 for GDP at level with intercept are less than the critical value at the 1%, 5% and 10% level of significance. Therefore the study cannot reject the null hypothesis that C02 and GDP are not stationary at level with intercept. Similarly, the LM statistic of 0.463000 for EC at level with intercept and trend is less than the critical value at the 1%, 5% and 10% level of significance. Therefore, the study also fail to reject the null hypothesis of EC is statiionary at level with intercept and trend. The study conclude that all the vectors are I(O)

In order to confirm the validity of the unit root tests conducted above, the thesis proceeded to carry out structural unit root test. This method of unit root test in the presence of structural break has an advantage over the other types of unit root tests. It has been observed that other unit root test techniques do not allow for a possible break which leads to a bias that makes it difficult to reject a false unit root null hypothesis. Similarly, it captured the possible outliers in the data for a specific variable at a given date which could provide vital information for determining whether a structural break on a particular variable is related to a specific event such as government policy, regime shifts, financial and economic crisis or certain unforeseen circumstances (Glynn, Perera & Verma, 2007). The test result is present in Table 5.3 below.

Table 5.3: Unit Root with Structural Breaks

Variables	Intercept	First difference	Break Date	Remark
CO_2	-3.614483	-8.268459***	2000	I(1)
EC	-3.748992	-9.260927***	1984	I(1)
GDP	-1.766690	-5.71131***	1983	I(1)

(Computed from E-views 10 Version)

Note:

****, **, * denotes the rejection of the null hypothesis at alpha 0.01, 0.05 and 0.1 significance level*

From Table 5.3 above, it’s observe that all the variables become stationary at first difference. For instance at level, the ADF-statistics of C02 (-3.614483), EC (-3.748992) and GDP (-1.76690) and their corresponding p-values are greater than critical values of -4.949133, -4.443649 and -4.193627 at 1%, 5% 10% level of significance respectively. Therefore, the study fails to reject the null hypothesis that the vectors are stationary at level. The inability of the study to reject the null hypothesis implies that the variables are non-stationary at their levels. At first difference, the ADF-statistic of C02 (-8.268459), EC (-9.260927) and GDP (-5.951131) and their corresponding p-values are less than the critical values of 4.949133, -4.443649 and -4.193627 at 1%, 5% 10% level of significance respectively. Therefore, the study rejects the null hypothesis that variables are having unit root at first difference.

Rejecting the null hypothesis implies that variables are stationary at first difference. The study conclude based on this that the variables are all 1(1).

Based on majority of the unit root tests conducted, it is asserted that the level of integration of the variables are of the same order (1) and are appropriate for the conducting of the co-integration test to determine the long-run relationship of the series.

5.4 Co-integration Analysis

5.4.1 Johansen Cointegration Test Result

Johansen Co-integration is appropriately adopted where the non-stationary series in the system are all I(1). The findings of ADF and PP stationarity test show that CO2, EC, and GDP are all I(1).

Thus, Johansen Co-integration test is carried out to determine the possible co-integration of CO2, EC, and GDP. Three hypotheses are set to include: 1. null hypothesis of no co-integrating vectors among CO2, EC, and GDP. 2. The alternative hypothesis of co-integrating variables is less than 1 or equal to 1. 3. There is at most two cointegrating vectors. See table 5.4 below.

Table 5.4: Johansen Test for Co-integration

Hypothesis	Eigenvalue	Trace-Stat	5% Critical Value	P-Value
None	0.2438	18.3677	29.7971	0.5390
At most 1	0.1439	6.6316	15.4947	0.6208
At most 2	0.0025	0.1065	3.8415	0.7441
Hypothesized No. if CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	Prob.
None	0.2438	11.7361	21.1316	0.5739
At most 1	0.1439	6.5251	14.2646	0.5468
At most 2	0.0025	0.1065	3.8415	0.7441

(Computation from Eviews 10 Verson)

Note:

Trace and Max-Eigen test shows no co-integrating equation(s). Lag length 1 is used as suggested by AIC and SIC in the selection process.

The result presented in Table 5.4 indicate the non-rejection of the null hypothesis at 0.05 significant levels indicating the non-existence of long-run correlation between EC, GDP growth and CO2 emissions considering the trace test and max-eigen test. The trace test show that the critical values of 29.7971, 15.4947 and 3.3815 are greater than the Trace-statistic of 18.3677, 6.6318 and 0.1065 at the 5% level of significance respectively. Similary considering the probability at none, at most 1 and at most 2 of 0.54, 0.62 and 0.74 are greater than the 0.05 level of significance. Therefore, the study cannot reject the null hypothesis meaning that there is no cointergration between the variables.

Furthermore, the Max-Eigen test result indicates that the critical value of 21.1316, 14.2646 and 3.8415 are greater than the Max-Eigen-statistic of 11.7381, 6.5251 and 0.1065 at the 5% level of significance respectively. The probability values of 0.5739, 0.5468 and 0.7441 are greater than the 0.05 level of significance. Therefore, the study fails to reject the null hypothesis, hence, the variables are not cointegrated. The implication of the results of Trace test as well as the Max-Eigen test is that EC, GDP and CO2 are not possibly related in the long run.

It should be noted that the series in the case above were used at their level form. The study when ahead to transform the data to see whether there could be any possible cointegration but the result indicates no difference (see Appendix 42 and 43).

Since there is no possible co-integration of the vectors, the study could not proceed with the ECM test and Granger causality test using the VECM. Any attempt to do so will produce spurious results which may be dangerous in terms of policy-making (Shrestha & Bhautta, 2018). However, the study conducted another cointegration test using Gregory Hansen method in the presence of structural break.

5.4.2 The Gregory Hansen (GH) Cointegration Test Result

Note that the cointegration test carried out above (Johansen) did not consider the possible effect of structural break in the estimation. Therefore, this thesis moved on to conduct the GH cointegration with structural break to determine susbsistence or otherwise of any long-run relationship amongst the series (see Table 5.5 below).

Table 5.5 Gregory Hansen (GH) Cointegration Test Model 2: Level Shift

Null Hypothesis: There is no cointegration

ADF Procedure		1%		5%	10%
t-stat	**-4.099687**	**-5.44**		**-4.92**	**-4.69**
Lag	0.000000				
Break	1987				
Phillips Procedure					
Za-stat	-23.34453	-57.01		-46.98	-42.49
Za-break	1987				
Zt-stat	**-4.116304**	**-5.44**		**-4.92**	**-4.69**
Zt-break	1987				

(Computation from Eviews 10 Verson)

Note:
The GH Critical Value at 0.01, 0.05 and 0.1 level of significant at level shift are -5.44, -4.92 and -4.69 respectively.

Based on the outcome of Gregory Hansen cointegration test, presented in Table 5.5, the study cannot reject the null hypothesis that the variables are not cointegrated. It is evident from the Table that the t-statistic of -4.099637 is less than the GH critical values of -5.44, -4.92 and -4.69 in absolute terms at 1%, 5% and 10% level of significance. Therefore the study cannot reject the null hypothesis that the vectors are not related in the long run. Similarly, Zt-statistic of -4.116304 is also less than the GH critical values of -5.44, - 4.92 and -4.69 in absolute terms at 1%, 5% and 10% level of significance. The study fails to reject the null hypothesis that variables are not cointegrated. Therefore, it is concluded that there is no long-run correlation between the variables given that both the t-statistic and Zt statistic are less than the corresponding G-H critical value at 0.05 level of significance with a structural break occurring at 1987.

However, Toda Yamamoto Granger Non-Causality (1995) is adopted to evaluate the causality existing among the variables irrespective of cointegration of the variables (Dave, 2011).

5.5 Toda Yamamoto Granger non-causality Result

At this point, the study employs Toda Yamamoto Granger non-causality model to investigate the causality between the use of electricity, GDP and CO2. This model provides for the test of Granger non-causality with or without the cointegration of the series. To carry out this test the research determined the dmax to be 1. The optimal lag length p is selected based on AIC and SIC to be 1. Structural Break test was conducted and dummy created to capture possible outliers. Similarly, a residual diagnostic test for autocorrelation and normality test is conducted within the Vector Auto Regression model as one of the requirements for using this model.

5.5.1 Vector Auto Regression Lag Length Selection

One of the requirements for Johansen Cointegration test and Toda Yamamoto method is the selection of the optimal lag k. Therefore, the Lag Length selected is based on automatic lag selection criteria as presented in Table 5.6.

Table 5.6: Lag Length Selection Criteria

Lag	Logl	LR	FPE	AIC	SIC	HQ
0	-450.6510	NA	2547325.	23.26415	23.39212	23.31006
1	-341.1844	196.4785*	14773.03*	18.11202*	18.62388*	16.29567*
2	-334.5262	10.92628	16819.14	18.23211	19.12787	18.55350
3	328.7952	8.523003	20358.08	18.39975	19.67942	18.85888
4	-321.0732	10.29601	22722.27	18.46529	20.12885	19.06216
5	-315,2315	6.890223	28784.76	18.62725	20.67471	19.36187

(Computation from Eviews 10 Verson)

Note:

AIC=Akaike information criterion; SC= Schwartz information criterion;

HQ= Hannan- Quinn information criterion

** indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error.*

Based on Table 5.6 above, all the methods of selection suggested 1 as the optimal lag length for the analysis. Therefore, the study employed lag 1 for the Johansen cointegration test as well as Toda Yamamoto Granger Non-Causality test.

5.5.2 Serial Correlation LM Test

Table 5.7 Serial Correlation Test Result

Ho: No serial correlation at lag 1

LAG	F STAT	PROBABILITY
1	0.929900	0.5047

(Computation from E-views version 10)

***Note**: the probability is at 5% level of significance.*

The above findings in Table 5.7 indicate that the variables are not serially correlated. For instance, the probability of 0.5047 is more than the 0.05 level. Therefore, the study cannot reject the null hypothesis that there is no serial correlation. The inability of the study to reject the null hypothesis implies that the residuals are not correlated and that errors in one period do not affect errors in another period. Therefore, the series are robust and unbiased.

5.5.3 Jarque-Bera Normality Test

Table 5.8: Jarque-Bera Normality Test result

Element	Jarque-Bera	DF.	Probability
1	0.076946	2	0.9623
2	0.020049	2	0.9900
3	4.488666	2	0.1060
Combine	4.585661	6	0.5979

Note the probability is at 5% level of significance.

(Computed from E-views 10.version)

The Jarque-Bera test which combines the Skewness and Kurtosis indicates that the residuals are normally distributed. For instance the probabilities of 0.96, 0.99 and 0.11 are more than the 0.05 significant level. Therefore, the study fails to reject the null hypothesis. The failure of the study to reject the null hypothesis implies that the residuals are normally distributed.

5.5.4 Residual Heteroscedasticity Test

Table 5.9: Heteroscedasticity test Result

Joint test:		
Chi-sq	Df	Prob.
86.72619	72	0.1137

(Computed from E-views 10.version)

The outcome of the heteroscedasticity test in Table 5.5.4 shows that there is no heteroscedasticity problem in the model. The probability value of 0.1137 is greater than the 5% level of significance. Therefore, the study fails to reject the null hypothesis of no heteroscedasticity. The failure to reject the null hypothesis indicate that the residuals in the model are homoscedastic.

5.5.5 Granger Causality Test

Table 5.10: VAR Granger Causality/Block Exogeneity Wald Test

Panel A: Dependent variable CO_2			
Excluded	Chi-sq	DF	Probability
EC	0.043134	1	0.8355
GDP	1.123134	1	0.2892
Joint	1.127119	2	0.5692
Panel B: Dependent variable EC			
Excluded	Chi-sq	DF	Probability
CO_2	1.651886	1	0.1987
GDP	0.179787	1	0.6716
Joint	2.797973	2	0.2468
Panel C: Dependent variable GDP			
Excluded	Chi-sq	DF.	Probability
CO_2	0.147934	1	0.7005
EC	0.022973	1	0.8795
Joint		2	0.9248

The outcome in Table 5.10 shows there is no causality moving between the variables. For instance, in Panel A the chi-sq of 0.043 exhibited by EC is not significant and the corresponding probability of 0.83 is greater than the 0.05 level of significance. Therefore, the study fails to reject the null hypothesis that electricity consumption does not Granger Cause environmental pollution. The failure to reject the null hypothesis implies that EC cannot influence CO2. In the same panel, the chi-sq of 1.123 and the corresponding probability value of 0.28 exhibited by GDP is greater than the 0.05 significant level indicating the non-rejection of the null hypothesis. The non-rejection of the null hypothesis is an indication that that GDP growth does not causes CO_2.

Similarly, in panel B, the study fails to reject the null hypothesis since the probability values of 0.1987 for C02 and 0.6716 for GDP are greater than 0.05 significant level. This implies that GDP growth and C02 cannot cause EC.

Similarly, In Panel C, it is also shown that the probability value of 0.7005 for C02 and 0.8789 for EC are both greater than 0.05 level of significance. Therefore, the study equally fails to reject the null hypothesis meaning that C02 and EC cannot cause GDP.

This result confirm that there is no causal correlation between the variables which seems to agree with the Johansen and Gregory Hansen test for cointegration which show that there is no cointegration between EC, GDP and C02. The study could not find any robust evidence to explain the validity of the EKC hypothesis in Nigeria. However, the finding is robust and in conformity with existing studies (Akpan & Akpan, 2012; Omisakin & Olusegun, 2009; Abimbola & Bello, 2010; and Akpan & Chucku, 2011).

CHAPTER 6

DISCUSSION OF RESEARCH FINDINGS

6.1 Introduction

This study determines the nexus between economic growth, electricity consumption and environmental pollution in Nigeria for the period of 1971-2014. The data were subjected to preliminary checks for stationarity using ADF and PP units root test techniques and the findings are presented in Table 5.1. In addition, KPSS unit root procedure was also used an alternative technique- and the result could be seen in Table 5.2.

Based on the results majority of the tests conducted, it is asserted that the series are all I(1) and are appropriate for the conducting of the co-integration test to establish whether there is long-run relationship among the series.

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The first test carried out is the Johansen co-integration. This methodology is consitent with the level of of integration of the varaibles which are all I(1) as observed in the preceeding section. Johansen-Cointegration provides two test statistics (trace and max-eigen) which are contrasted with the critical values for establishing the subsistence or otherwise of any long run relationship. Both the trace and max-eigen test indicate the non-rejection of the null hypothesis at 0.05 levelsv which indicates that EC, GDP growth and CO_2 emissions are not cointegrated (See Table 5.4). The result is in conformity and agreement with similar studies in the Nigerian context as a developing country. The study by Omisakin & Olusegun (2009) adopted the EKC in Nigeria convering the period of 1970 to 2005 and equally discovered no causal correlation as well as long run correlation between GDP and CO2. Similarly, Attf & Siddiqi employed the Engle-Granger Cointegration nethod and Granger causality techniques in Pankistan spanning from 1971 to 2007 and found that GDP is not related to CO2 as well as electricity uterlization in the long period. Note that Pakistan is a developing country like Nigeria wih slow growth rate. The implication of these findings as compared to this finding is that GDP is independent of electricity consumption as well as C02 emissions.

The non-existence of long run relationship established above prompted further investigation. Therefore, the study employed the Gregory Hansen cointegration method in the presence of structural break to confirm the outcome of the Johansen cointegration. The finding from the test also indicate that there is no long run relationship among the variables. The result presented in Table 5.5 indicate that the t-statistic as well as Zt-statistics are less than the GH critical values in absolute terms. The study once more could not reject the null hypothesis; meaning that the variables are not cointegrated. Based on the outcome of the Johansen and GH, the study fails to carry out the proposed VECM test as well as the Granger Causality in the VECM model.

However, the study employs a Toda Yamamoto Granger Non-Causality model to determine the existence of causality between the vectors. Following this model, the research determines the optimal lag VAR(p) and dmax.
The outcome in Table 5.10 shows the non rejection of the null hypothesis which implies the absence of causality among the series. This highlights the understanding that there cannot be causality when there is no cointegration among the series.

Therefore, on the bases of the three methodologies adopted, it is concluded that the result tends to uphold the neutrality hypothesis which assumed that increase environmental pollution is independent of any increase GDP growth.

Given that GDP does not have any implication on C02, the reliance of EKC hypthesis on increasing GDP towards reducing environmnetal pollution in the long run would not essentially achieve the desired objective in a developing nation such as Nigeria.

This tends to be consistent with the observation of Marques, Fuinhas & Leal (2018) that the validity of the EKC hypothesis can vary according to the country or countries studied. This means that there is no generalized consensus about the relationship between economic growth and environmental degradation. Similar studies in Nigeria confirm the non-support for the EKC hypothesis using different methodologies at different periods (see Omisakin & Olusegun, 2009; Alege & Ogundipe, 2015 and Law, Ali & Zannah, 2016). On the contrary, the findings by Annicchiarico et al. (2009) in Italy and Armeanu et al. (2016) in EU-20 countries upheld the EKC hypothesis. The EKC is most likely in developed markets than developing markets. Therefore, policy measures towards mitigating the environmental pollution could best advanced in line with peculiarity of the country. This has significant implication policy formaulation and practice in Nigeria.

When one takes the EKC hypothesis at its face value, ominous signs could indicate that economic growth ought to be most important policy targets of the public authorities, with the security of the environmental conditions as minor objective that could be left for the future. Policy makers ought to take into cognizance of the literatures which tend to emphasized sustainable environment which significantly posits that social welfare rather than GDP ought to be the principal focal point of government policies.

Based on the empirical result, the study recommends the implementation of the following policies:

- **Increasing public awareness on the use of clean technology to reduce C02 emissions.**

  As in the popular maxim “knowledge is power”. In adequate understanding of the likely C02 reducing energy sources in Nigeria could stand as a barrier to wide scale embracing of renewable energy technologies in both industrial and residential houses. Therefore, overcoming poor information infrastructure in order to increase the intensity of consciousness of the possible C02 reducing technologies both in costs and benefits as well as the accessibility and established practices is exceedingly required.

- **Energy demand management policy.**

  Increasing the capacity and responsiveness of energy demand management policy in the country is necessary. This essentially entails the urgency to create establish a reliable indicators, measures as well as clean energy equipment that could encourage rational energy consumption which would be accessible to the government for the reason of successful execution of the policy/strategy.

- **Legislative and Regulatory Support**

  In the context of the research outcome, pragmatic policy implication of the public authorities which has the capacity to incentivize the consumption of environmentally friendly technologies equipment ought to be executed in Nigeria. For this reason, industries could be encouraged to employ and deploy renewable energy productive machines in the activities. This would substantially increase not only the company’s productivity but also the overall quality of the environment.

Even though no statistically significant result was found between C02 emissions and GDP, enforcement of environmental sustainability regulations in line with Kyoto guidelines ought to be pursued. Therefore, the use of solar system, wind energy and other technologies should be encouraged

- **Technology transfer and acquisition**

  It should be noted that the United Nations Framework Convention on Climate Change (UNFCCC) as well as the Kyoto Protocol call for that each and every player make efforts that are regular with lessening of Greenhouse emissions. Article 4 Paragraph 5 of the UNFCCC demands that the Annex I player should be encouraged towards transferring environmentally efficient or clean technologies to developing economies. Likewise, Article 10 in Paragraph (c) as contained in the Kyoto Protocol oblige that all players' collaborate in the encouragement of efficient methods for the expansion, adoption as well as the distribution of, and adopt doable actions to support, assist and fund, as suitable, the transfer of, or accessibility to, viable clean technology, knowledge, practices and procedures applicable to, relevant to climate change, particularly to low-income economies, together with the designing of strategies and activities for the efficient convey of C02 reducing gadgets that are widely owned or in the unrestricted sphere and the construction of a conducive atmosphere for private enterprises, to encourage and improve the transfer of, and access to, clean technologies.

  In this case, the Clean Development Mechanism (CDM) - an instrument funded by advanced economies which aspire to encourage sustainability in the low income economies as well the recently developed economies ought to effectively discharge its role. UNFCCC and the Kyoto Protocol Article 12 contains that 'reduction of greenhouse substances could simply be licensed when programmes/projects create 'factual, quantifiable, as well as durable/long-run gains connected to the climate change reduction' and 'mitigation in gaseous discharge that are supplementary to whichever that would arise in the deficiency of the licensed programme activity (Renewable Energy World 1999).

It is a fact that environmentally friendly technologies are appropriate for the for the all-encompassing technology transfer towards mitigation or reduction of C02 emissions, the requirements of both the UNFCCC as well as the Kyoto Protocol is yet to be executed to any considerable level. There is a huge prospective for CO2 emission mitigation in the Nigerian economy; this make Nigeria eligible for CDM finance. In this regard, the need to design practicable course of action for the CDM execution by both the advanced as well as the developing economies. In this case, strong domestic capacity is required if Nigeria would benefit from C02 reducing or renewable energy system technology transfer policy.

- **Elimination of Energy Supply restrictions/Inadequate Inducements and Stimulus**

  In the Nigerian context, the use of C02 reducing technologies and energy efficiency is often constrained by the structure of the electric energy supply. Due to unpredictable electrical energy supply, the enthusiasm to implement energy efficient technology is restricted. Similarly, a wide-ranging deficiency in inducements in the form of tax rebates or lifting of Tariffs on imports of environmentally friendly equipment tends to constrains importing businessmen as well as the final consuming public. Preferential loans to firms and investors towards the creation and or importation of cleaner technologies for manufacturing would also help in saving the environment rather than the traditional concentration on raising GDP. Similarly, the financial sector ought to give much priority in financing C02 mitigating ventures. Recently, governments around the globe have emphasized the issuance of 'Green Bond' to assist in addressing the challenges of rising global warming. Nigeria can take queue in this direction.

- **Institutional support and strengthening**

  As identified above, C02 reducing programs/projects which seek to trim down avoidable energy consumption cost via detection and removal of inefficiencies ought to be in place. This calls for the compilation and appropriate investigation of applicable information, which could assist in showing whether or not there is necessity for progress and efficiency in energy consumption with ultimate impact on C02 reduction.

Accordingly, the enlargement, use and distribution of environmentally viable sources of energy in the country particularly for decentralized electricity power production and supply into the Nigerian market entail having a sufficient institutional base. At the moment, Nigeria only has two national energy research areas dedicated to the science and technology of solar energy.

Given that Nigeria is a participant to the Convention, It thrieves to deliver to some degree in line with its developmental objectives to meet its responsibilities and requirements to the UNFCCC. At the same time, country recognizes the assistance from bilateral and multilateral institutions to address global warming. It seems clear that the intensity of support obtained up to now has not been sufficient enough to permit the counrty to vigorously perform its functions accordingly.

CHAPTER 7
CONCLUSION

The study set out to examine the nexus between environmental pollution, GDP growth and electricity demand from 1971 to 2014, and to propose some pragmatic policy implications towards reducing C02 emissions in Nigeria. The entire data were sourced from the World Bank. Electricity is measured by electricity demand per capita, economic growth is measured by gross domestic product per capita and environmental pollution is measured by CO2 emissions per capita

The subject matter regarding the link between C02 emissions, energy use and GDP per capita growth has received significant interest in energy and environmental economics. As observed in the literature reviewed, diverse analyses have concentrated on different countries and tend to differ on the scope of analysis, choice of proxy variables and econometric techniques to examine the relationship between the variables. The outcomes of these scholarly investigations tend to vary and sometimes tend to be incompatible leading to variations in policy implications of these variables.

The present thesis made use of three complementary econometric techniques to examine the legitimacy of the Environmental Kuznets Hypothesis in the Nigerian context.

The empirical evaluation of the study started with the evaluation of the statistical properties of the data using the ADF, PP as well as the KPSS unit root tests. This was necessary in order to ascertain the level of integration of the series and to circumvent meaningless or spurios estimates. The stationarity tests outcomes generally indicate that the series becomes stationary only at first difference. In addition, multiple structural breaks were carried out to capture the possible outliers in the data.

Johansen cointegration test and Gregory Hansen test show the absence of cointegration among the variables. Similarly, the Toda Yamamoto Granger Non-Causality reveals that there is no causal relationship among series. To ensure the robustness of these findings, a diagnostic test for serial correlation, heteroskedasticity, and normality were conducted. The results show that residuals are not auto-correlated and are normally distributed.

The implication of the causality results is that GDP per capita growth does not influences environmental pollution in Nigeria. The investigation shows the variables do not share any relationship in the long run. This is also demonstrated by the outcome of impulse response function that the variables diverge over time.

Perhaps, the amount of carbon dioxide emissions as compared to some countries in the world such like United States of America, Japan, United Kingdom China to mention but a few has not reached an alarming stage to cause significant damage to the climate. The result is persuasive given the that fact that Nigeria is not listed among the top 40 countries in the world by total Carbon dioxide emissions from 1990 to 2013 (EU Edgar database, 2017).

The C02 emission-GDP nexus shows that any policy effort to ignore environmental protection in the context of Nigeria by relying on raising GDP to address its present environmental pollution could largely leads to misplacement of priority. It is asserted that Nigeria cannot “grow itself” out of its environmental challenges, therefore the necessity of transcending the EKC theory.

Over the last five decades of existence as an independent country, Nigeria has not designed an all-inclusive national energy policy in order to lessen its greenhouse emissions. At best, Nigeria could only brag of energy policy measures at the sub-sectoral level. The need to fashion a comprehensive national energy policy is necessary. This could be beneficial to the country in developing an integrated sustainable energy policy that is crucial for utilizing energy even more resourcefully and distribute C02 reducing energy equipment. Similarly, the fashioning of a comprehensive strategy will also act as a mechanism in driving transfer and acquisition of fitting technologies adapted to suit domestic climate

The study views increasing fiscal and financial support importers and firms in order to develop apply and diffuse environmentally friendly technologies would significantly assist in reducing C02 emissions. In addition, the study believes that and outreach programmes is necessary to increase the intensity of consciousness of the potentials and gains C02 reducing technologies to both the policy makers and the broad-spectrum public is needful.

The Nigerian government could take steps towards incentivizing the use renewable energy technologies and purposefully enforce environmental regulations. This would also improve the environmental quality

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APPENDIX

1. ADF Unit Root Test for CO2 at Level without Constant and Trend

H0: CO2 has unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-0.56819	0.4653	Non stationary
Test critical values	1% level	-2.61985		
	5% level	-1.94869		
	10% level	-1.61204		

2. ADF Unit Root Test for CO_2 at Level with Constant only

H0: CO2 has unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-2.014611	0.2797	Non stationary
Test critical values	1% level	-3.59246		
	5% level	-2.93140		
	10% level	-2.60394		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

3. ADF Unit Root Test for CO_2 at Level with Constant and Trend

H0: CO2 has unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-2.48678	0.3328	Non stationary
Test critical values	1% level	-4.18648		
	5% level	-3.51809		
	10% level	-3.18973		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

4. ADF Unit Root Test for CO_2 at First difference and Constant

H0: D (CO2) has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-7.70372	0.0000	Stationary
Test critical values	1% level	-3.59662		
	5% level	-2.93316		
	10% level	-2.60487		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

5. ADF Unit Root Test for EC at level without Constant and Trend

H0: EC has unit root

		t-statistic	Probability*	Remark
ADF t-statistics		1.47638	0.9633	Non stationary
Test critical values	1% level	-2.62119		
	5% level	-1.94889		
	10% level	-1.61193		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

6. ADF Unit Root Test for EC at level with Constants only

H0: EC has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-1.29372	0.6240	Non stationary
Test critical values	1% level	-3.59246		
	5% level	-2.93140		
	10% level	-2.60394		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

7. ADF Unit Root Test for EC at Level with Constant and Trend.

H0: EC has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-3.04809	0.1317	Non stationary
Test critical values	1% level	-4.18648		
	5% level	-3.51809		
	10% level	-3.18973		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

8. ADF Unit Root Test for EC at first difference

H0: D (EC) has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-8.83767	0.0000	Stationary
Test critical values	1% level	-3.59662		
	5% level	-2.93316		
	10% level	-2.60487		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

9. ADF Unit Root Test for GDP at Level without Constant and Trend

H0: GDP has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		0.72930	0.8685	Non stationary
Test critical values	1% level	-2.62119		
	5% level	-1.94889		
	10% level	-1.61193		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

10. ADF Unit Root Test for GDP at Level with Constant only

H0: GDP has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-0.07164	0.9459	Non stationary
Test critical values	1% level	-3.59662		
	5% level	-2.93316		
	10% level	-2.60487		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

11.**ADF Unit Root Test for GDP at Level with Constant and Trend**

H0: GDP has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-0.33613	0.9861	Non stationary
Test critical values	1% level	-4.25288		
	5% level	-3.54849		
	10% level	-3.20709		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

12. ADF Unit Root Test for GDP at First difference

H0: D (GDP) has a unit root

		t-statistic	Probability*	Remark
ADF t-statistics		-2.97694	0.0455	Stationary
Test critical values	1% level	-3.60099		
	5% level	-2.93500		
	10% level	-2.60584		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

13. PP Unit Root Test for CO2 at Level without Constant and Trend

H0: CO2 has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-0.52090	0.4852	Non stationary
Test critical values	1% level	-2.61985		
	5% level	-1.94869		
	10% level	-1.61204		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

14. PP Unit Root Test for CO2 at Level with Constant only

H0: CO2 has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-2.02260	0.2764	Non stationary
Test critical values	1% level	-3.59246		
	5% level	-2.93140		
	10% level	-2.60394		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

15. PP Unit Root Test for CO2 with Constant and Trend

H0: CO2 has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-2.60241	0.2813	Non stationary
Test critical values	1% level	-4.18648		
	5% level	-3.51809		
	10% level	-3.189732		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

16. PP Unit Root Test for CO2 at First difference

H0: D (CO2) has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-7.703715	0.0000	Stationary
Test critical values	1% level	-3.59662		
	5% level	-2.93316		
	10% level	-2.60487		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

17. PP Unit Root Test for EC at Level without Constant and Trend

H0: EC has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		1.50713	0.9655	Non stationary
Test critical values	1% level	-2.61985		
	5% level	-1.94869		
	10% level	-1.61204		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

18. PP Unit Root Test for EC at Level with Constant only

H0: EC has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-1.08975	0.7114	Non stationary
Test critical values	1% level	-3.59246		
	5% level	-2.93140		
	10% level	-2.60394		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

19.PP Unit Root Test for EC at Level with Constant and Trend

H0: EC has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-3.08826	0.1220	Non stationary
Test critical values	1% level	-4.18648		
	5% level	-3.51809		
	10% level	-3.18973		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

20. PP Unit Root Test for EC at First difference

H0: D (EC) has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-9.25062	0.0000	Stationary
Test critical values	1% level	-3.59662		
	5% level	-2.93316		
	10% level	-2.60487		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

21. PP Unit Root Test for GDP at Level without Constant and Trend

H0: GDP has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		0.62880	0.8483	Non stationary
Test critical values	1% level	-2.61985		
	5% level	-1.94869		
	10% level	-1.61204		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

22. PP Unit Root Test for GDP at Level with Constant only

H0: GDP has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-0.31690	0.9138	Non stationary
Test critical values	1% level	-3.59246		
	5% level	-2.93140		
	10% level	-2.60394		

*Macknnon (1996) one sided probability values

(Eviews 10 version)

23. PP Unit Root Test for GDP at Level with Constant and Trend

H0: GDP has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-0.22215	0.9905	Non stationary
Test critical values	1% level	-4.18648		
	5% level	-3.51809		
	10% level	-3.18973		

*Macknnon (1996) one sided probability values

(Eviews 10 version

24. PP Unit Root Test for GDP at First difference

H0: D (GDP) has a unit root

		Adj. t-statistic	Probability*	Remark
PP t-statistics		-5.045504	0.0002	Stationary
Test critical values	1% level	-3.596616		
	5% level	-2.933158		
	10% level	-2.604867		

*Macknnon (1996) one sided probability values

(Eviews 10 versio)

25. Unit Root with Structural Breaks for C02 at Level

H0: C02 has a unit root

		Adj. t-statistic	Probability*	Break Date	Remark
ADF-Statistics		-3.614483	0.3233	1986	Non stationary
Test critical values	1% level	-4.949133			
	5% level	-4.443649			
	10% level	-4.193627			

*Volgelsang (1993) asymptotic one sided p-values
(Eviews 10 version)

26: Unit Root with Structural Breaks for C02 at First Difference

H0: D(C02) has a unit root

		Adj. t-statistic	Probability*	Break Date	Remark
ADF-Statistics		-8.268459	< 0.01	2000	Stationary
Test critical values	1% level	-4.949133			
	5% level	-4.443649			
	10% level	-4.193627			

*Volgelsang (1993) asymptotic one sided p-values

(Eviews 10 version)

27. Unit Root with Structural Breaks for EC at Level

H0: EC has a unit root

		Adj. t-statistic	Probability*	Break Date	Remark
ADF-Statistics		-3.748992	0.2584	2001	Non stationary
Test critical values	1% level	-4.949133			
	5% level	-4.443649			
	10% level	-4.193627			

*Volgelsang (1993) asymptotic one sided p-values

(Eviews 10 version)

28. Unit Root with Structural Breaks for EC at First Difference

H0: D(EC) has a unit root

		Adj. t-statistic	Probability*	Break Date	Remark
ADF-Statistics		-9.260927	< 0.01	1984	Stationary
Test critical values	1% level	-4.949133			
	5% level	-4.443649			
	10% level	-4.193627			

*Volgelsang (1993) asymptotic one sided p-values

(Eviews 10 version)

29. Unit Root with Structural Breaks for GDP at Level

H0: GDP has a unit root

		Adj. t-statistic	Probability*	Break Date	Remark
ADF-Statistics		-1.766690	0 > 0.99	2006	Non stationary
Test critical values	1% level	-4.949133			
	5% level	-4.443649			
	10% level	-4.193627			

*Volgelsang (1993) asymptotic one sided p-values

(Eviews 10 version)

30. Unit Root with Structural Breaks for GDP at First Difference

H0: D(GDP) has a unit root

		Adj. t-statistic	Probability*	Break Date	Remark
ADF-Statistics		-5.751131	< 0.01	1983	Stationary
Test critical values	1% level	-4.949133			
	5% level	-4.443649			
	10% level	-4.193627			

*Volgelsang (1993) asymptotic one sided p-values

(Eviews 10 version)

31. KPSS Unit Root Test for C02 at Level with Intercept

		LM Statistic
KPSS T-Statistic		0.299781
Asymptotic critical values	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

32. KPSS Unit Root Test for C02 at Level with Intercept and Trend

		LM Statistic
• KPSS T-Statistic		0.111457
Asymptotic critical values	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

33 KPSS Unit Root Test for D(C02) at first difference with Intercept

		LM Statistic
• KPSS T-Statistic		0.095245
Asymptotic critical values	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

34. KPSS Unit Root Test for EC at level with Intercept

		LM Statistic
• KPSS T-Statistic		0.755296
Asymptotic critical values	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

35. KPSS Unit Root Test for EC at level with Intercept and Trend

		LM Statistic
• KPSS T-Statistic		0.096609
Asymptotic critical values	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

36 KPSS Unit Root Test for D(EC) at first difference with Intercept

		LM Statistic
• KPSS T-Statistic		0.072825
Asymptotic critical values	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

37. KPSS Unit Root Test for GDP at level with Intercept

		LM Statistic
• KPSS T-Statistic		0.231820
Asymptotic critical values	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1

38. KPSS Unit Root Test for GDP at level with Intercept and Trend

		LM Statistic
• KPSS T-Statistic		0.231820
Asymptotic critical values	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1

39 KPSS Unit Root Test for D(GDP) at first difference with Intercept

		LM Statistic
• KPSS T-Statistic		0.431665
Asymptotic critical values	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

40. The Gregory Hansen Cointegration Test Model 2 Level Shift

ADF Procedure	
t-stat	-4.057283
Lag	0.000000
Break	1980
Phillips Procedure	
Za-stat	-26.83315
Za-break	1980
Zt-stat	-4.105300
Zt-break	1980

41 Johansen Test for Cointegration

Date: 07/31/19 Time: 14:35
Sample (adjusted): 1973 2014
Included observations: 42 after adjustments
Trend assumption: Linear deterministic trend
Series: C02 EC GDP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None	0.243786	< 18.36773 >	29.79707	0.5390>0.05
At most 1	0.143893	<6.631654>	15.49471	0.6208>0.05
At most 2	0.002533	<0.106528>	3.841466	0.7441>0.05

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.
None	0.243786	<11.73607>	21.13162	0.5739>0.05
At most 1	0.143893	<6.525127>	14.26460	0.5468>0.05
At most 2	0.002533	<0.106528>	3.841466	0.7441>0.05

Max-eigenvalue test indicates no cointegration at the 0.05 level

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

C02	EC	GDP
-6.099845	-0.031088	0.001749
-2.864920	0.025536	-0.000368
0.256758	-0.006188	-0.002906

Unrestricted Adjustment Coefficients (alpha):

D(C02)	0.046286	0.008342	-0.002543
D(EC)	-1.567813	-2.684859	-0.387058
D(GDP)	-1.588192	24.47549	-3.601977

1 Cointegrating Equation(s): Log likelihood -366.7746

Normalized cointegrating coefficients (standard error in parentheses)

C02	EC	GDP
1.000000	0.005097	-0.000287
	(0.00175)	(0.00014)

Adjustment coefficients (standard error in parentheses)

D(C02)	-0.282339
	(0.09868)
D(EC)	9.563414
	(10.8406)
D(GDP)	9.687726
	(96.6696)

2 Cointegrating Equation(s):		Log likelihood	-363.5121

Normalized cointegrating coefficients (standard error in parentheses)

C02	EC	GDP
1.000000	0.000000	-0.000136
		(0.00018)
0.000000	1.000000	-0.029647
		(0.03165)

Adjustment coefficients (standard error in parentheses)

D(C02)	-0.306238	-0.001226
	(0.10863)	(0.00065)
D(EC)	17.25532	-0.019819
	(11.6015)	(0.06926)
D(GDP)	-60.43260	0.674369
	(103.301)	(0.61668)

4.2 Johansen Cointegration with transform data

Date: 08/13/19 Time: 12:57
Sample (adjusted): 1973 2014
Included observations: 42 after adjustments
Trend assumption: Linear deterministic trend
Series: LN_C02 LN_EC LN_GDP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None	0.211655	18.05348	29.79707	0.5621
At most 1	0.174569	8.065080	15.49471	0.4585
At most 2	0.000176	0.007405	3.841466	0.9310

Trace test indicates no cointegration at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.
None	0.211655	9.988402	21.13162	0.7458
At most 1	0.174569	8.057675	14.26460	0.3729
At most 2	0.000176	0.007405	3.841466	0.9310

Max-eigenvalue test indicates no cointegration at the 0.05 level

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

43 Johansen Cointegration Test Summary

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

44. Vector Autoregression Lag selection criteria

Endogenous Variables: CO2 EC GDP (1971 to 2014)						
39 observations included						
Lag	Logl	LR	FEP	AIC	SIC	HQ
0	-450.651	NA	254732.	23.2642	23.3921	23.3101
1	-341.184	196.478*	14773.0*	18.1120*	18.6239*	18.2957*
2	-334.526	10.9262	16819.1	18.2321	19.1279	18.5535
3	-328.795	8.52300	20358.1	18.3998	19.6794	18.8589
4	-321.073	10.2960	22722.3	18.4653	20.1289	19.0622
5	-315.231	6.89022	28784.8	18.6273	20.6747	19.3619

Note:

LR: Sequential modified LR test statistic
FPE: Final prediction
AIC: Akaike Information Criterion
SIC: Swartz Information Criterion
HQ:
*indicates lag order selected by the criterion

Note:
* Significant Level 0.05

45. VAR Residual Serial Correlation LM Test

Lag	LRE* Statistic	DF	Probability	Rao F-Statistic	DF	probability
1	8.303140	9	0.5039	0.929900	(9, 73.2)	0.5047

Note
HO: No serial correlation at up lag 1

46. Var Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)				
Sample size 1971 to 2014 (42 observations included)				
Element	Skewness	Chi-square	DF	Probability*
1	-0.049836	0.017385	1	0.8951
2	0.025723	0.004632	1	0.9457
3	-0.445930	1.391976	1	0.2381
Combine		1.413993	3	0.7023
Element	Kurtosis	Chi-square	DF	Probability*
1	2.815515	0.059561	1	0.8072
2	3.093862	0.015418	1	0.9012
3	4.330240	3.096690	1	0.0785
Combine		3.171669	3	0.3659
Element	Jarque-Bera	DF	Probability*	
1	0.076946	2	0.9623	
2	0.020049	2	0.9900	
3	4.488666	2	0.1060	
Combine	4.585661	6	0.5979	

Note:
*Approximate p-values do not account for coefficient estimation

47. VAR Residual Heteroskedasticity Tests

Joint test:

Chi-sq	Df	Prob.
86.72619	72	0.1137

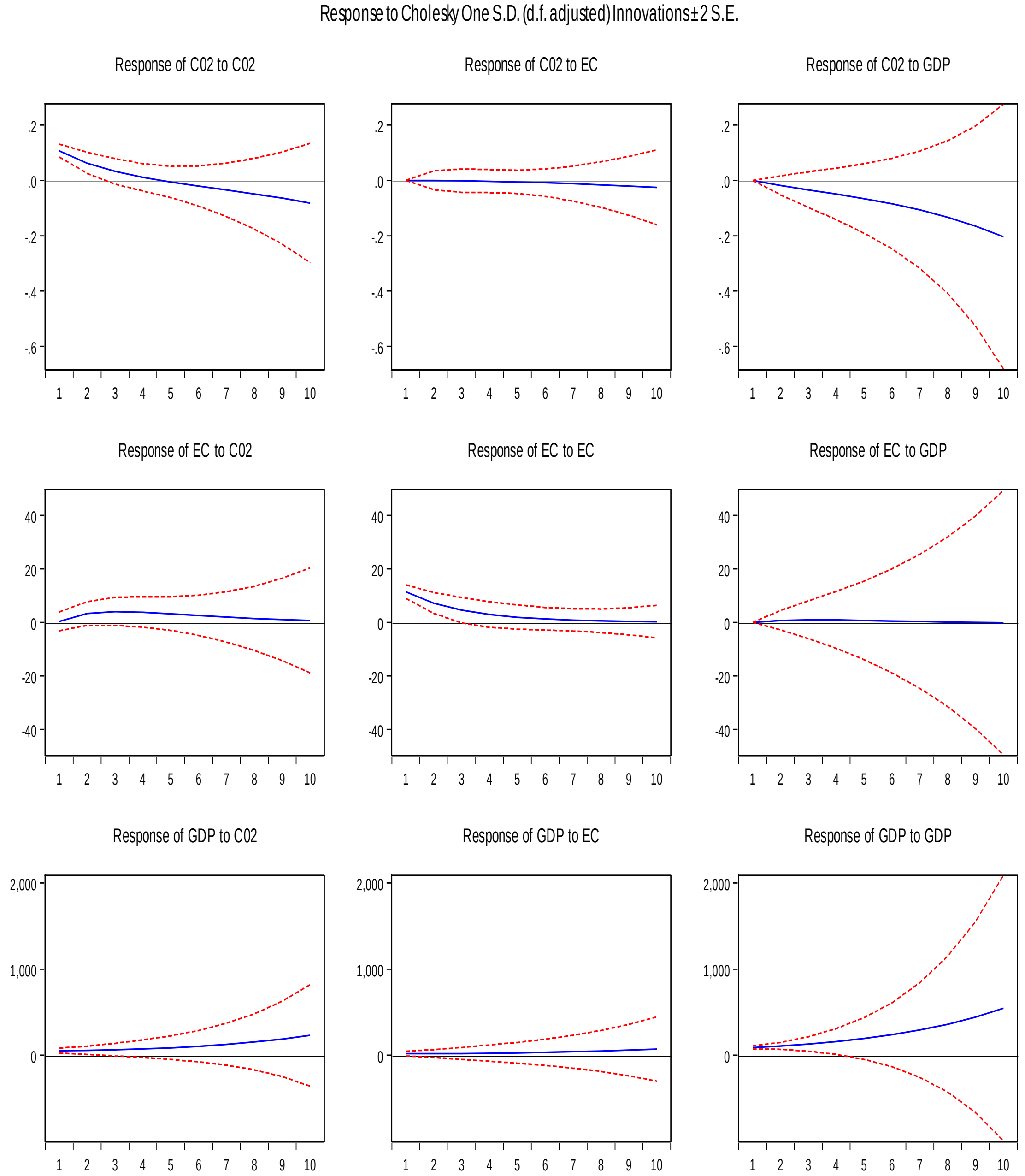
Individual components:

Dependent	R-squared	F(12,29)	Prob.	Chi-sq (12)	Prob.
res1*res1	0.220672	0.684295	0.7525	9.268219	0.6799
res2*res2	0.386933	1.525264	0.1714	16.25120	0.1800
res3*res3	0.543041	2.871918	0.0099	22.80772	0.0294
res2*res1	0.369002	1.413248	0.2158	15.49810	0.2153
res3*res1	0.350375	1.303428	0.2691	14.71575	0.2574
res3*res2	0.319967	1.137082	0.3703	13.43861	0.3380

48. VAR Granger Causality/Block Exogeneity Wald Test

Sample size 1971 to 2014 (42 observations included)			
Dependent Variable CO2			
Excluded	Chi-square	DF	probability
EC	0.043134	1	0.8355
GDP	1.123134	1	0.2892
Total	1.127119	2	0.5692
Dependent Variable EC			
Excluded	Chi-square	DF	probability
C02	1.651886	1	0.1987
GDP	0.179787	1	0.6716
Total	2.797973	2	0.2468
Dependent Variable GDP			
Excluded	Chi-square	DF	probability
C02	0.147934	1	0.7005
EC	0.022973	1	0.8795
Total	0.156249	2	0.9248

49: Impulse Response Function



50 Data from World Bank Indicators

DATE	EC	CO2	GDP
1971	28.57132	0.563408	1897.839
1972	32.72954	0.706176	1915.961
1973	35.30169	0.824779	1970.647
1974	32.85038	1.010017	2135.064
1975	45.77618	0.747882	1969.169
1976	51.57434	0.847006	2086.239
1977	59.16763	0.752322	2146.444
1978	60.66943	0.696954	1962.069
1979	59.79721	0.984561	2033.144
1980	68.02274	0.927773	2058.951
1981	50.87268	0.873822	1740.745
1982	81.84797	0.846782	1580.636
1983	81.68656	0.754192	1372.717
1984	62.02626	0.854322	1323.501
1985	80.40587	0.835908	1366.293
1986	90.83123	0.856517	1331.996
1987	89.2492	0.673575	1338.998
1988	87.08652	0.782169	1399.882
1989	97.01182	0.457129	1389.961
1990	87.02636	0.411426	1514.098
1991	89.54599	0.432567	1481.331
1992	90.00059	0.465119	1511.345
1993	100.8255	0.43924	1443.989
1994	95.50496	0.334102	1382.873
1995	91.43474	0.331828	1347.892
1996	85.85524	0.358213	1369.932
1997	81.95717	0.372861	1375.514
1998	76.92522	0.325376	1376.309
1999	75.72464	0.337607	1350.225
2000	74.44912	0.621626	1382.895
2001	75.52798	0.683342	1428.406
2002	104.6036	0.728061	1606.356
2003	101.8697	0.76998	1681.184
2004	123.5656	0.770377	1790.293
2005	129.2577	0.763411	1856.93
2006	111.693	0.693421	1918.704
2007	138.8363	0.649214	1992.049
2008	127.1788	0.639511	2071.202
2009	120.5747	0.496985	2178.899
2010	136.3617	0.577111	2291.36
2011	150.1316	0.587523	2349.298
2012	156.733	0.58879	2383.977
2013	142.6765	0.571126	2475.948
2014	144.4799	0.545622	2563.092

PLAGIARISM REPORT

ORIJINALLIK RAPORU

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ETHICS COMMITEE APPROVAL

07.08.2019

Dear Bakshak Yerima Sati

Your project **“The Nexus between Electrıcıty Consumptıon, Economıc Growth and Envıronmental Pollutıon: Evıdence from Nıgerıa”** has been evaluated. Since only secondary data will be used the project it does not need to go through the ethics committee. You can start your research on the condition that you will use only secondary data.

Assoc. Prof. Dr. Direnç Kanol

Rapporteur of the Scientific Research Ethics Committee

Direnc Kanol

Note: If you need to provide an official letter to an institution with the signature of the Head of NEU Scientific Research Ethics Committee, please apply to the secretariat of the ethics committee by showing this document