Carbon Footprint and Economic Growth in Selected African Countries

Vivian Nekpen ENOMHENSIKE
PG/MGS1715972

A THESIS WRITTEN AND SUBMITTED IN THE DEPARTMENT OF FINANCE, FACULTY OF MANAGEMENT SCIENCES, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY (MPhil) DEGREE IN FINANCE

JUNE, 2025

DECLARATION

I, **Vivian Nekpen ENOMHENSIKE** hereby declare that this thesis titled "Carbon Footprint and Economic Growth in Selected African Countries" has been carried out by me. The work embodied in the project has not been submitted in candidature for any degree and is not concurrently being submitted for any other degree. All other references made to works of other person have been duly acknowledged.

______________________________ _____   ____________________

Vivian Nekpen ENOMHENSIKE   **Date**
(*MPhil Student/Researcher*)

CERTIFICATION

This is to certify that this research work was carried out by **Vivian Nekpen ENOMHENSIKE** in the Department of Finance, Faculty of Management Sciences, University of Benin, Benin City, in partial fulfilment of the requirements for the award of a Master of Philosophy (MPhil) Degree in Finance.

______________________________ ____________________

Dr. E. Isibor **Date**
(Supervisor)

______________________________ ____________________

Dr. O.G. Omorokunwa **Date**
(Head of Department)

CERTIFICATION OF NON-PLAGIARISM OF THESIS

This is to certify that the thesis of **Vivian Nekpen ENOMHENSIKE** titled **Carbon Footprint and Economic Growth in Selected African Countries,** has successfully passed the anti-plagiarism test, and does not disobey any copyright regulations as indicated by TurnItIn similarity index.

______________________________ ____________________

Dr. E. Isibor **Date**
(Supervisor)

______________________________ ____________________

Dr. O. G. Omorokunwa **Date**
(Head of Department)

ATTESTATION

We the undersigned attest that **Vivian Nekpen ENOMHENSIKE** has successfully carried out all the corrections as recommended by the external examiner and internal examiner in this thesis titled: **“Carbon Footprint and Economic Growth in Selected African Countries”**.

__________________________ __________________

Dr. E. Isibor **Date**

(Supervisor)

__________________________ __________________

Dr. O. G. Omorokunwa **Date**

(Head of Department)

__________________________ __________________

Dr. S.U. Eboigbe **Date**

(Internal Examiner)

DEDICATION

This thesis is dedicated to God Almighty, who made all things possible.

ACKNOWLEDGEMENT

My profound appreciation goes to my distinguished supervisor Dr. E. Isibor for his invaluable guidance, feedback, and intellectual stimulation. In spite of his very busy schedule, he painstakingly read through this research work, made significant corrections and guided me throughout the duration of this project. God bless you immensely sir.

I also wish to express my hearty gratitude to the Dean of Management Sciences, Prof. Enofe, my able and very hardworking H. O. D of Finance, Dr. O. G. Omorokunwa, and all other professors, lecturers and staff of Finance department for their contributions to my personal, intellectual and professional growth in profound ways. God bless you all.

I am thankful to my dear husband, my children, my dearest parents Mr and Mrs O. G. Eguavoen, and also, my siblings for their unending love, prayers, understanding and unwavering support. They were truly my support system all through this journey of success. I will continue to make you all proud.

My appreciation goes to my good friends who made this journey enjoyable and fulfilling, special thanks to Mr Ben Ukim, Hon. Charity, Mrs Rita, Mr Andrew, Dr. Omorose, among others, for their undivided support, interest, and encouragement in the course of this research.

Finally, I appreciate my course-mates class of MPhil and MSc Finance who assisted me in their own way. Thank you and God bless you all.

TABLE OF CONTENTS

CHAPTER THREE

METHODOLOGY

CHAPTER FOUR

DATA PRESENTATION AND ANALYSES

LIST OF TABLES

LIST OF ABBREVIATIONS

ARDL ECM	Autoregressive Distributed Lag Error Correction Model
AMCEN	African Ministerial Conference on Environment
ADF	Augumented Dicky Fuller
AIC	Akaike Information Criterion
BR	Brundtland Report
CBN	Central Bank of Nigeria
CDM	Clean Development Mechanism
CFCs	Chlorofluorocarbons
CEF	Conservation Energy Future
CO_2	Carbon Emission
D-W	Durbin-Watson
DOLS	Dynamic Ordinary Least Square
EDN	Environmental Degradation
EG	Economic Growth
EQ	Environmental Quality
EP	Energy Policy
EF	Ecological Footprint
EC	Energy Policy
EU	European Union
ECT	Error Correction Term
ECM	Error Correction Model
ELC	Electricity Consumption
ED	Economic Development
FOF	Fossil Fuel
FDI	Foreign Direct Investment
FMOLS	Fully Modified Ordinary Least Square
GHGs	Greenhouse Gases
GDP	Gross Domestic Product
GLS	General Least Square
GMM	Generalized Method of Moments
HCP	Human Capital
IMF	International Monetary Fund
LEAP	Long-run Energy Alternative Planning
NRE	Non-renewable Energy
OC	Oil Consumption
OLS	Ordinary Least Square
OPEC	Organization of the Petroleum Exporting Countries
RE	Renewable Energy
R & D	Research & Development
SOE	State Owned Enterprises
SDGs	Sustainable Development Goal
TOPN	Trade Openness
UN	United Nations
VAR	Vector Autoregressive
VIF	Variance Inflation Factor
VECM	Vector Error Correction Model

WBDI	World Bank Development Index
WB	World Bank

ABSTRACT

The study examined the influence of carbon footprint on Economic Growth (EG) of selected African countries. Quarterly time series data and panel data of five (5) African countries from 1980 to 2023 were sourced from the World Bank Development Index (WBDI) database. Statistical techniques of descriptive statistics, correlation analysis, stationarity test, co-integration test, Error Correction Model (ECM) and panel Vector Error Correction Model (VECM) were employed to analyse the data. Findings show that four (4) out of five countries traded-off Economic Growth to reduce carbon emissions in the long run. Thus, EKC (Environmental Kuznet Curve) proposition is confirmed in these countries (Nigeria, Algeria, Libya, and Egypt). Also, electricity consumption, human capital, and trade openness are significant channels via which renewable energy technology may affect the countries' Economic Growth, although in different magnitude. In Africa, Economic Growth must be traded-off in the long run to reduce the quantum of consumption carbon emission (CO_2) in the long run. Only trade openness is identified as a significant conduit via which renewable energy technology impact the region's Economic Growth. From the foregoing analysis, the study concludes that better EKC hypothesis practice and favourable trade openness is a useful tool for preventing environmental degradation process and promoting economic growth and development in Africa.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Global warming and climate change are major barriers to macroeconomic goals such as sustainable development and a specific level of Economic Growth (EG) that are sought after by both developed and developing nations. This is because fossil fuels account for a sizeable amount of the world's energy consumption demand, which has led to a large increase in carbon dioxide (CO_2) emissions (Acheampong, Dzator, & Savage 2021; Alege, Adediran & Ogundipe, 2016). Furthermore, due to increased resource usage with higher pollutant emissions, relatively dirty technologies, and a disregard for the environmental effects of expansion, the early stages of industrialization and development advancement can encourage environmental degradation (Gaber, 2011). But as Economic Growth goes on, big industries shift to cleaner, knowledge-based, and service-based sectors (Shafik, 2002) and investment in renewable energy like electricity and education will reduce carbon emission significantly (Pata & Kartal, 2023; Ali & Kirikkaleli, 2022).

Within the recently established Sustainable Development Goals (SDGs), everyone is encouraged to pursue both sustainable economic growth and a high level of life (Salahuddin et al, 2020; Costanza, 2014). In the end, ecological assets' ability to provide primary resources and life-supporting ecological services determines economic activity (Adeleye, Osabohien, Lawal, & De Alwis, 2021; Costanza, 2014) Decision-makers worldwide are having difficulty managing these services, which has become a major concern (United Nations [UN], 2014). Due to the rise in greenhouse gases (GHGs) in the atmosphere over the past century, resulting from burning of fossil fuels like coal, natural gas, and oil, as well as extensive deforestation have increased the concentration of CO_2 in the atmosphere. This is because burning coal or oil releases carbon dioxide into the atmosphere which is formed when carbon combines with oxygen. The concentration of greenhouse gases has also increased due to other human activities such as respiration, industrial processes, and clearing land for agriculture (UN, 2023; Olubusoye & Dasauki, 2018).

According to Ozturk and Acaravci (2010), CO_2 is the most prevalent atmospheric gas and plays a crucial function of up to 60% in enhancing the greenhouse effect. Africa continues to be the most vulnerable continent to the dynamic magnitude of climatic effects. The continent's low level of industrial growth has made it the region with the lowest source of CO_2 emissions when compared to other regions like Asia, the United States of America, and Europe (Bewket, 2012). Africa's temperature is predicted to rise from two (2) to six (6) degrees Celsius over the next century (100 years) and sub-Saharan Africa is expected to lose US$26 million in 2060 as a result of climate change, draught, and severe flooding already exceeding plants and animals’ tolerance thresholds, driving mass mortalities in species such as trees and corals (International Panel on Climate Change [IPCC], 2007; 2022). Similarly, records for surface temperatures, sea level rise, acidity and heat of the ocean, Antarctic sea ice cover, and glacier retreat were also broken, if not completely shattered globally. Weather hazards continued to cause displacement in 2023, demonstrating how climate shocks impair resilience and generate new protection risks among the most vulnerable groups is paramount (World Meteorological Organisation [WMO], 2023).

For the majority of African nations, especially those that depend on burning fossil fuels for energy production - such as petrol, or premium motor spirit (PMS), diesel, firewood, and charcoal - non-renewable energy is the primary energy source. These forms of energy release harmful amounts of carbon dioxide into the atmosphere over time. Therefore, higher Economic Growth for Africa will result in more carbon emissions that worsen the environment and increase the ripple effects of climate change throughout the continent

(Olubusoye & Dasauki, 2018). The global north and south appears to be experiencing an exponential rate of increase in emissions despite efforts to curb carbon emissions (Acheampong et al., 2021).

1.2 Statement of the Research Problem

One of the biggest problems facing humanity in the twenty-first century is climate change caused by fossil fuels from gas, oil, and coal, which has led to increasingly intense and frequent weather patterns reinforced by rising sea levels and melting glaciers that have an impact on both the natural world and human populations (UN, 2023; Olubusoye & Dasauki, 2018). Crude oil production is the main driver of economic growth (EG) in several oil-producing countries in Africa, and the relationship between Environmental Quality (EQ) and Economic Growth remains puzzling. According to the Environmental Kuznets Curve (EKC) hypothesis, there is a direct correlation between income and carbon emissions up until a certain income threshold is reached. After that point, carbon emissions start to decrease and form an inverted *U*-shaped relationship (Grossman & Krueger, 1995).

On the contrary, the Environmental Daly Curve (EDC) hypothesis assert that economic expansion is directly related to CO_2 emission and emerging nations lack the resources to invest significantly in clean energy technology that will repair the degree of environmental damage done. Thus, the trend continues and the inverted *U*-shaped curve is not feasible (Daly, 1973). Even with the Economic Growth documented from available resources in many developing African countries, that environmental deterioration is exacerbated by a lack of accountability, a shaky rule of law, low-quality institutions, and significant levels of corruption (Smulders, 2000). However, renewable energy like electricity consumption and open trade creates the chance for Economic Growth and improvement in environmental quality (Salahuddin et al. 2020; Kahia, Aissa & Lanouar, 2017; Ozturk & Almulali, 2015).

Furthermore, the desire for increased foreign exchange earnings from crude oil export is a salient driver of Economic Growth amidst African countries, which pushed these countries to open-up trading activities with other country of the world. Trade openness (free trade) can increase carbon emission via environmental goods consumption, which can increase volume of world trade and specific country output and adversely influence environmental quality (Mesagan, 2015). As economic expansion accelerates, these diverse issues have led to a high rate of carbon emissions. Since Kraft and Kraft's (1978) seminar study on the causal relationship between Economic Growth and energy consumption, researchers, economists, academics, and policy makers have been interested in examining the relationship between carbon footprint and Economic Growth across various continents due to the rise in carbon emissions and the on-going global warming crisis.

Famous and prominent among these studies are Elom et al (2024), Pata and Kartal (2023); Ali and Kirikkaleli (2022), Acheampong et al. (2021), Salahuddin et al. (2020), Olubusoye and Dasauki (2020), Schroder and Storm (2018), Shahbaz, Nasreen, Ahmed and Hammoudeh (2017), Alege, Adediran and Ogundipe (2016), Ejuvbekpokpo (2014), Aye and Edoja (2017), Mesagan (2015), Asici and Acar (2015) among others. Some of these studies explored the influence of Economic Growth on carbon footprints (Schroder & Storm, 2018; Aye & Edoja, 2017; Mesagan, 2015).

Some studies investigated the impact of CO_2 emissions on Economic Growth (Osadume & Edih, 2021; Olubusoye & Dasauki, 2020; Alege, Adediran & Ogundipe, 2016; Ejuvbekpokpo, 2014 among others). However, the findings of these studies were mixed; even for some studies that used similar techniques. These mixed findings may be due to difference in variables included, transformation made to data used, panel of countries studied, sample period, estimation techniques adopted, and more study is needed in Africa to know the actual position of EKC hypothesis in Africa.

Only few studies like that of Osadume and Edih (2021) and Olubusoye, et al (2020) have cross country study in nature on carbon emission and economic growth relationship among low-middle, upper-middle income, and West African economies respectively. It was observed clearly in the literature that the study that tested the EKC hypothesis and the Environmental Daly Curve (EDC) hypothesis of carbon emission and economic growth nexus within the five (5) largest oil producing countries in Africa was not found in the literature to the best of my knowledge; hence studies are needed in this direction.

On the basis of methodology, study that combines the Autoregressive Distributed Lag (ARDL) model and panel Vector Error Correction Model (VECM) framework to test the validity of EKC and EDC hypothesis in each and the entire selected African countries sampled with quarterly time series and panel data are very scarce in the literature. Thus, it is imperative to know the actual effect of non-renewable energy emission of fossil fuel (oil, gas fuel, and charcoal) and renewable energy (electricity consumption), human capital and trade openness on EG in the five largest oil producing countries in Africa and the theory that holds between EKC and EDC in Africa. Hence, this study examines the effect of carbon footprint on EG in Africa.

1.3 Research Questions

From the statement of the problem, the following questions are raised:

1. What is the effect of carbon emission (CO_2) on Economic Growth in selected African countries?
2. What is the effect of trade openness on Economic Growth in selected African countries?

3. To what extent does human capital impact Economic Growth in selected African countries?
4. How does fossil fuel affect Economic Growth in selected African countries?
5. What is the effect of electricity consumption on Economic Growth in selected African countries?

1.4 Objectives of the Study

The broad objective of this study examined the effect of carbon footprint emission on Economic Growth in selected African countries. The specific objectives are to:

1. determine the effect of carbon (CO_2) emission on Economic Growth in selected African countries.
2. investigate the influence of trade openness on Economic Growth in selected African countries.
3. study the extent to which human capital affect Economic Growth in selected African countries.
4. examine how fossil fuel affects Economic Growth of selected African countries.
5. ascertain the influence of electricity consumption on Economic Growth in selected African countries.

1.5 Hypotheses of the Study

The underlying hypotheses tested in this study are stated in their null form;

CO_2 emission has no significant effect on Economic Growth in selected African countries.

Trade openness has no significant effect on Economic Growth in selected African countries.

Human capital has no significant effect on Economic Growth in selected African countries.

Fossil fuel has no significant effect on Economic Growth in selected African countries.

Electricity consumption has no significant effect on Economic Growth in selected African countries.

1.6 Scope of the Study

This study which spans a forty-four-year period (1980–2023), focuses on the major oil producing economies in Africa and covers the sixteen (16) oil producing countries in Africa (Trading Economics, 2023). Africa was chosen because of the great concentration of oil operations in the region and the fact that oil production in African oil producing nations has historically been a major factor in economic progress. Africa was also chosen because, although being among the least carbon-footprint polluters, it is among the most adversely affected continent. The time frame was chosen because it encompasses the range of environmental conservation measures that African nations have implemented to lessen environmental deterioration and so accelerate regional economic growth. Additionally, the period was inspired by the data availability for each panel in the chosen nation.

1.7 Significance of the Study

This study is significant being the first among the scanty study in the case of Africa to adopt the most recent data, ARDL and VECM techniques to test the validity of EKC and EDC hypothesis among the largest oil producing countries in Africa, thereby fills this gap in knowledge. This study used high frequency quarterly time series and panel data which is different from annual data used in prior studies to reveal the nexus between carbon footprint and economic growth in Africa thereby avoiding duplication of effort. Also, the findings helped to ascertain whether carbon footprint is a significant determinant of Economic Growth in the selected African countries and how to interpret carbon emission in Africa with respect to their economic growth, thereby updating extant literature. Specifically, the findings of the study are of immense benefit to the following stakeholders: Investors, Government and Policy makers, Academics, and future researchers.

Investors: It will help international investors recognise and take into account the characteristics of carbon-sensitive assets in the African region. This will lower portfolio risk over the course of the investment horizon as a result.

Government and Policy Makers: The government and policy makers will be able to formulate and implement more effective policies that will reduce greenhouse gas emissions beyond what is required for business as usual and improve environmental quality due to the clear view provided by the study's findings.

Academics and Researchers: The results will help academics push the boundaries of knowledge, which will be beneficial. Additionally, it will help climate change experts who provide services to financial institutions find new, uncommon assets with unusual risk and return characteristics that are expected to arise in a future where carbon emissions are forbidden and that might last for a longer period of time and within business circles.

1.8 Limitations of the Study

A study cannot exist without constraints. The first research constraint could have been related to issues with data outliers, unit roots, serial correlation, and multi-colinearity, which can impair the accuracy of the ARDL ECM and VECM methodologies that were employed in this investigation. Second, the ARDL ECM and panel VECM estimation methodologies have limitations due to small sample sizes of forty-four (44) annual data and two hundred and twenty (220) panel data observations, respectively. These techniques produce efficient reliable estimate with a larger sample observations.

However, the first limitation was handled by conducting a preliminary test of descriptive statistics, stationarity test, optimal lag selection, post regression test of Durbin Watson statistics; Breausch-Godfrey serial correlation test, and Variance Inflation Factor (VIF) to reduce or eliminate the impact of these perceived short comings on the reliability and authenticity of the result. By calibrating (converting) the annual time series and panel data to quarterly data using E-views 10.0, which has a higher frequency than annual data, the second constraint was eliminated. Thus, the number of observations was greatly increased significantly from 44 (forty four) annual observations to 176 (one hundred and seventy six) quarterly observations and from 220 (two hundred and twenty) panel observations to 880 (eight hundred and eighty) observations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The review of conceptual literature, theoretical literature, and empirical literature of carbon footprint with regards to economic growth is the main focus of this chapter. This chapter is chronologically arranged in the direction of conceptual, theoretical, and empirical literature.

2.2 Conceptual Literature

2.2.1 Concept of Economic Growth

The market value of tangible and intangible output produced in a nation over a given length of time, often a year, is known as economic growth (EG) (Lequiller & Blades, 2006). Any nation's Economic Development (ED) depends on having an excellent Energy Policy (EP), since energy and Economic Growth is inextricably linked. Hence, Economic Growth determines a significant extent to how the economy of African countries performs. Gross Domestic Product (GDP) is a macroeconomic indicator that gauges economic operations and portrays the economy strength by evaluating the absolute value of intangible and physical output created within an economy during a given year. It is considered as the most widely used indicator to measure the overall size of an economy. The growth of GDP is a prosperous economy's indicator (Soava, Mehedintu, Sterpu & Raduteanu, 2018).

Economic growth (EG), according to Potters and Munichiello (2024), is the rise in the output of products and services relative to a prior period of time. Real or nominal measurements are possible for it. Traditionally, gross national product (GNP) or gross domestic product (GDP) has been used to quantify aggregate economic growth.

As a result, we may define GDP as a model that captures the worth of a country's output over time as expressed in monetary terms. Increasing a country's production capacity and making effective use of its resources are the keys to achieving Economic Growth (Haller, 2012).

Similarly, it may also be described as a sustained rise in net national product or national output per person. That is, the rate of increase in overall productivity must be higher than the rate of rise in the population (Egbunike, Emudainohwo & Gunardi, 2018). Following the Industrial Revolution, the global economy has experienced significant growth. Because of the flourishing industries, the standard of life for citizens, especially in developing nation, is rising in tandem with population growth (Zhang, 2023).

The final production approach (expenses method), the production method (value added method), and the income method (revenue method) are the three approaches typically used to calculate GDP. Since there is no other way to sum up the various commodities and services produced within an economy, the GDP growth rate computed by the spending technique at market price value (millions of dollars) was employed in this study (Soava, et al., 2018). Furthermore, GDP expression at current market values eliminates pricing disparities across nations, making it a valuable tool for evaluating living standards throughout the globe and in African nations (Soava et al., 2018; Potters & Munichiello, 2024). GDP main component when determined by expenditure approach are private consumption (φ) government expenditure (ω), Total investment $(\nexists)$ and net export (X^n). The quantitative expression is given as;

$$\mathrm{GDP} = (\varphi) + (\omega) + (\nexists) + \mathrm{X^n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The level of Economic Growth and ED in each continent (country) depends on a number of factors. Several ED mechanisms are based on unique national characteristics and perhaps accessible natural resources in order to support rapid economic growth (Aye & Edoja, 2017; Potters & Munichiello, 2024). The overuse of natural resources, pollution of the environment, climate change, and habitat loss for species are just a few of the ways that the increase may negatively affect the environment (Phimphanthavong, 2013). These are the main problems that African nations are facing, particularly the degradation of EQ, which is regarded as a basic problem for the population's living conditions from both a short-and long-term viewpoint (Aye & Edoja, 2017).

According to Shahzad, Mohammed, Schneider, Faggioni and Papa (2023), fluctuations in GDP are crucial for understanding the dynamics of global development as they represent the actual income and state of the economy of the nation. However, the accuracy of GDP projections has a significant impact on the economic assessment carried out by a country's market committee, which is responsible for monitoring overall economic development and inflation (Ericsson, 2016; Watanabe, Naveed, Tou & Neittaanmäki, 2018). Concurrently, accurate GDP projections are crucial for corporate managers and analysts to draw the right conclusions and make the best decisions on upcoming projects.

2.2.2 Concept of Carbon Footprint

Carbon dioxide (CO_2) emission quantity (herein after referred to carbon or CO_2 emissions) related to person, country, buildings, and corporation entire operations is termed carbon footprint (Selin, 2020). Direct emissions from Fossil Fuel (FF) combustion in industrial activities transportation, heating and the needed emissions to provide electricity (both tangible and intangible output consumed) are considered as CO_2 emissions. Also, it covers other greenhouses gases emissions such as nitrous oxide or chlorofluorocarbons (CFCs) and methane (Selin, 2020). Carbon footprint concept emanated from the ancients' idea of ecological footprint discovered in the early 1990s by William Rees and Mathis Wackernagel at British Columbia University (Wackernagel & Rees, 1996). They describe ecological footprint as the total land dimension required to sustain a population or human activity. It accounts for environmental impacts including the quantity of water and land used for food production. Carbon footprint (CFP) in contrast, is often expressed as a measure of weight in tons of CO_2 or its equivalent annually (Selin, 2020).

CFP vary from a country's per capita emissions report (like the United Nations Framework Convention on Climate Change report). Instead of emissions from green-house gases that are related to production (per capital emissions), CFP (CO_2) concentrates on consumption of greenhouse gas emissions. They are emissions emanated during goods importation produced elsewhere and take cognisance of international transport emissions like shipping, which standard national inventories do not account for. Hence, a country's CFP can rise even with decreased CO_2 emissions within its borders (Ishida, 2011). Fossil fuel (FF) includes slow-entropy resources like oil, coal, and gas which seem to be indispensable for growth of the economy. It means that a decrease in fossil fuel consumption may deter economic growth (EG). Conversely, non-fossil energy seems not to positively affect Economic Growth (Ishida, 2011). FF mainly contains carbon and hydrogen. FF burning combines oxygen, carbon and hydrogen to form CO_2 and water (H_{20}). For instance, for an equal quantity of energy produced natural gas burning contributes about half of the CO_2 quantity produced by coal burning. From the foregoing description, Carbon Footprint (CFP) and per capita emissions (fossil fuel) are the major non-renewable energy factor that increases environmental degradation.

Environmental Quality (EQ) degradation bacon on the worrisome concern about increase in climate change caused mainly by Greenhouse Gases (GHGs) emissions (Uddin, Salahuddin, Alam, & Gow, 2017; Kasman & Duman, 2015). Environmental goods and services are different from other resources like financial benefits; the ecological relevant decision made about them today will affect both the quality and quantity of future generations (Clayton, Kals, & Feygina, 2016)

2.2.3 Concept of Environmental Degradation

Economic growth (EG) is largely driven by industrialisation and development, which is heavily impacted by environmental degradation (ED). Environmental degradation is the term used to describe the deterioration of the environment caused by the depletion of resources like soil, water, air, ecosystem disruption, species extinction, habitat destruction, and pollution (Conservation Energy Future [CEF], 2016). Also, it is the collapse or degradation of the planet (environment) and the extinction of wildlife. According to CEF (2016), it is defined as any undesired alteration to nature's turf that is thought to be harmful. Environmental degradation was defined by Johnson et al. (1997) as an environmental disturbance that is either harmful or undesirable.

In the twenty-first century, the need for environmental sustainability has never been greater. This comes after environmental degradation became overbearing (Osuntuyi & Learn, 2023). According to the World Economic Forum (WEF), environmental risks make up four of the top five threats the world is currently facing, and they are also the five most likely long-term global threats (WEF, 2021). The biggest obstacles to achieving the Sustainable Development Goals (SDGs) are thought to be environmental dangers resulting from environmental degradation. This is true since environmental hazards have an impact on every community, business, and person (Acheampong & Osei-Opoku, 2022). The world cannot vaccine against it, nor is it a peril to which no one is immune (WEF, 2021). Emissions of carbon dioxide are the primary driver of climate change and it has been the primary source of these hazards.

Huesemann and Huesemann (2011) and Chertow (2001) further described environmental deterioration using the equation:

$I = PAT$.

Where:

I = Environmental impact,

P = Growing population

A = Per capita income

T = Pollution causing technology

The above formula implies that the causes of environmental impact include the already large and growing population (P), the continuously rising Economic Growth or per capita income (A), the depletion of resources, and the usage of pollution-causing technologies (T). Ecological Footprint (EF) is defined as an accounting resource tool that includes two basic indicators: bio capacity, which is considered to be the supply side, and ecological footprint, which is the demand side. Human demand for the biosphere's renewable natural capital is measured by the former, which quantifies the amount of productive biological area that people utilise and demand for their well-being. It encompasses the biological resources-plant, animal, and fish—that they eat, the land used to house all buildings and other infrastructure, and the space used to store carbon waste from burning fossil fuels (Wackernagel, Lewan & Hansson, 1999). The latter explains the Earth's supply side, which quantifies and monitors the amount of land and sea area that is biologically productive within a nation, region, or global area. The budget of human society ecology, or bio capacity, is a measure of the renewable natural capital that both humans and wild animals should be able to survive in (Wackernagel et al., 1999).

According to Kahia, Ben Aissa, and Charfeddine (2016), the imbalance between population increase, industrial development, and finite energy supplies results in the depletion of CO_2, fossil fuels, and other non-renewable energy. However, the use of renewable energy resources, such electricity, increases environmental quality and offers opportunities for economic development (Ozturk & Al-Mulali, 2015; Kahia, Aissa, & Lanouar, 2017). Increased use of natural resources, waste build-up, and pollution concentration all have a beneficial impact on the deterioration of environmental quality, which lowers human living standards even as income rises (Daly, 1991). Energy is now seen as the most important strategic product and the most tangible tool for social and economic growth (Sahir & Qureshi, 2007). According to Ayoade (2003), since the industrial revolution, the amount of CO_2 in the earth's atmosphere has increased. Around 280 parts per million (ppm) of CO_2 were present during the start of the industrial revolution, and this level remained consistent for roughly 700 years. However, CO_2 emissions have increased exponentially in the atmosphere at a growth rate of about 1860 parts per million, or 0.5% per year (Mohamed, Shaaban, Azza, & Mowafy, 2012).

Emissions of CO_2 were predicted by Botkin and Keller (1997) to reach 450 parts per million by 2050. It is generally acknowledged that more CO_2 is released into the atmosphere as the country's economy grows and industrial activity increases. The ecosystem and human habitat have been significantly impacted by the environmental consequences of CO_2 emissions as well as a number of environmental hazard breakouts caused by the shockingly dynamic environmental temperature in recent years. Aye and Edoja (2017) list these risks as the economic sector's susceptibility to floods, cyclones, the loss of animal and plant populations, disease vectors like malaria, ice breakage and freezing on lakes and rivers, a decline in food production, a rise in mortality, and threats to sustainable development. It becomes vital to quantify the effect of CO_2 on the Economic Growth of developing African nations.

Notwithstanding the COVID-19 pandemic-related decline in 2020, global energy-related CO_2 emissions continued to reach 31.5 Gt, helping to raise the average annual concentration of CO_2 in the atmosphere to 412.5 parts per million in 2020, which is about 50% higher than it was at the start of the industrial revolution. As the economy and the demand for coal, oil, and gas both recover, global energy-related CO_2 emissions are predicted to rise by 4.8% in 2021 (Bhatt, Davawala, Joshi, Shah & Unnarkat, 2023). Additionally, they projected that by 2047, the critical CO_2 level of 500 ppm will be reached. This level is regarded as irreversible. To return the emissions to safe levels, a 6.37% decrease rate and a 23.38% reversal rate are needed.

2.3 Overview of Carbon Emission in Africa

A key climate change mitigation strategy is reduction in Green House Gas (GHG) emissions. Specifically, international efforts to prevent and avoid harmful climate change is aimed at reducing global CO_2 emissions to net-zero emissions by 2050 (IPCC, 2018; Ayompe, Davis & Egoh, 2021). While historical emissions are dominated by industrialized nations, energy demands in emerging economies is on the increase as this may soon absolutely exceed industrialized nation's emission (Quadrelli & Peterson, 2007). Africa at present contribute only 4% of global CO_2 emissions but Africa developing trajectory could increase Africa's emission with certain emerging countries becoming big emitters when compared to some advance nations (Ayompe, Davis & Egoh, 2021). The Paris Agreement of 2015 was a historic achievement in multilateral diplomacy. It stipulates that emissions should be reduced in countries in various developmental stages to mitigate climate change threat. Accordingly, emerging country Parties should continue enhancing their mitigation efforts, and are encouraged to move over time towards economy-wide emission reduction or limitation targets in the light of different national circumstances' (UNFCCC, 2015). Therefore, sustainable development goals 7 (SDG 7) requires countries around the world to ensure access to affordable, reliable, sustainable and modern energy while also reducing CO_2 emissions.

Africa is one of the continents in which about 50% of the population does not have access to electricity and more than 60% still rely on traditional biomass for cooking (International Energy Agency [IEA], 2019). Although, energy accessibility is a top priority providing access to modern energy services to these areas under a business as-usual policy scenario in most African countries will result in substantial increases in both primary energy supply and CO_2 emissions by 2030 (Hamilton & Kelly, 2017). This is because in many African countries, existing policies will not prevent such increase in energy-related CO_2 emissions (Tajudeen, 2015). In addition, increasing population in many African countries will also lead to an increase in energy demand and potentially CO_2 emissions. Current population growth in Africa coupled with economic development plans such as Agenda 2063 (African Union [AU], 2010) could thus lead to significant increase in emissions from the continent without simultaneous efforts to decrease the energy intensity of economic activities and/or the carbon intensity of energy used; this will certainly increase climate change. Africa has the highest rates of population growth at present ~2.3% per year in recent years, and the continent's population is projected to approximately double by 2050, reaching 2.5 billion. Indeed, of the additional 2.0 billion people who may be added to the global population by 2050, more than a billion (1.05 billion, or 52%) are projected to live in countries of sub-Saharan Africa (United Nations Department of Economic and Social Affairs [UNDESA], 2019).

Climate change threatens sustainable development. Settlements in regions that are today water-deficient – including much of North Africa – can be expected to face still-higher demands for water as the climate warms. Beset by poverty, Acquire Immune Deficiency Syndrome (AIDS) and other challenges, African countries may lack the resources to address these emerging and expected climate change impacts (United Nations Fact Sheet on Climate Change [UNFSCC], 2006). Between 1990 and 2017, oil production in Africa increased by an average of 0.9% yr^{-1}, led by oil-rich countries like Angola, Egypt, Libya, and Algeria [14]. The compounded effects of drivers of emissions such as those mentioned above could see many African countries currently regarded as low emitters become major sources of CO_2 emissions. African governments work through a number of regional and global institutions to strengthen their response to climate change. They coordinate their regional positions and national policies on climate change through the African Ministerial Conference.

On the Environment (AMCEN), whose secretariat is provided by the Nairobi-based United Nation Environment Programme. Another important regional forum is the New Partnership for Africa's Development (NEPAD), which promotes projects and action plans relevant to climate change. At the global level, African countries can tap a variety of funds and institutions for support. Such funds includes the Special Climate Change Fund and the Least Developed Country Fund created under the United Nations Framework Convention on Climate Change (UNFCCC), the Adaptation Fund under the Kyoto Protocol, the Global Environment Facility, the World Bank, and other UN and intergovernmental organizations and programmes. African countries can also participate in the Clean Development Mechanism (CDM), an innovative market-based instrument of the Kyoto Protocol that finances sustainable development projects in developing countries, which reduce greenhouse gas emissions (UNFSCC, 2006).

A number of adaptation projects have been started in Africa to address a range of climate change impacts. These include projects on incorporating climate change in water resources management in Tanzanian, improving food security in Mozambique, and coping with coastal flooding and drought in East and Southern Africa. UN agencies have embarked on a wide array of projects throughout the continent to improve energy efficiency that reduces greenhouse gas emissions, such as through the solar power, hydropower, alternative fuels, and sustainable construction (UNFSCC, 2006).

As climate impacts intensify globally, It was found that nations must deliver dramatically stronger ambition and action in the next round of Nationally Determined Contributions (NDCs) or the Paris Agreement's 1.5°C goal will be gone within a few years. The finding is in the 15th edition report in a series that brings together many of the world's top climate scientists to look at future trends in greenhouse gas emissions and provide potential solutions to the challenge of global warming (Emissions Gap Report, 2024). Carbon footprint is different from ecological footprint. The former refers to the entire greenhouse gas (GHG) emissions released by organizations, events, individuals or product expressed as carbon dioxide (CO_2) equivalent that comes from fossil fuel burning; released into the atmosphere to cause climate change. The latter is concerned with the sum amount of land and water a population or individual uses to produce the resources it consumes and to absorb the waste it generates. Thus, carbon footprint is a subset of ecological footprint (Vitality, 2023). This is further depict in figure 1

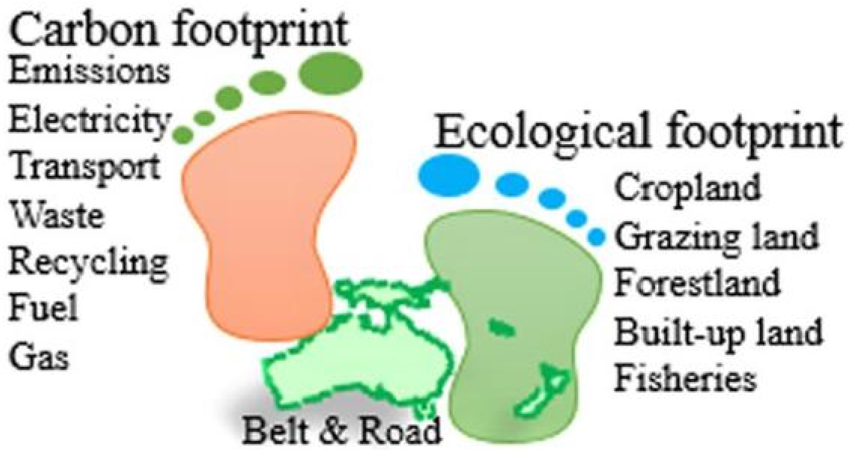


Figure 1: Carbon Footprint and Ecological Footprint
Source: Natural Resources Modelling (2024)

2.3.1 State of the Art

Research from the New Climate Economy shows that bold climate action could deliver at least $26 trillion in global economic benefits between now and 2030 and it could also generate over 65 million new low-carbon jobs by 2030 which is equivalent to the combined work forces of the United Kingdom and Egypt today. And also, avoid over 700,000 premature deaths from air pollution compared with business-as-usual and generate an estimated $2.8 trillion in government revenues in 2030 through subsidy reform and carbon pricing alone (Global Commission on the Economy and Climate [GCEC], 2018). Delivering the benefits of a new climate economy requires ambitious action across key economic systems, creating the conditions for the phase out of coal and rapid scale-up of renewables in the energy sector; investing in shared, electric, and low-carbon transport in cities, scaling up sustainable food and land use systems, including forest landscape restoration; targeting investment to resilient water infrastructure and reducing emissions from key industrial value chains such as plastic.

However, if the world fails to step up climate action on our current climate trajectory; it could force 100 million people into extreme poverty by 2030 (Stephene, 2016). Africa is the most-exposed region to the adverse effects of climate change despite contributing the least to global warming. The region is already disproportionately feeling the impacts related to a changing climate. Devastating cyclones affected 3 million people in Mozambique, Malawi, and Zimbabwe in the spring of 2018 (Yarnell & Cone, 2019). GDP exposure in African nations vulnerable to extreme climate patterns is projected to grow from $895 billion in 2018 to about $1.4 trillion in 2023 nearly half of the continent's GDP (Dahir, 2018).

But building the new climate economy is also a once-in-a-lifetime opportunity that every African nation should prioritize and claim a stake in. This opportunity is why, despite historically negligible carbon emissions which accounted for 2% of world coal demand and 4% to global carbon emission, and regardless of the lack of leadership from some developed countries many African countries are now making serious efforts to transition towards low-carbon technologies, low-carbon and resilient infrastructure, and low-carbon tax systems. Morocco has built the world's largest concentrated solar facility to help achieve the country's goal of 52% renewable energy mix by 2030. The advanced 6,000-acre solar complex, Noor, serves as a clean energy source for around 2 million Moroccans, and provides pivotal job opportunities as the country transitions away from the fossil fuel industry (Climate Investment Fund [CIF], 2019). The solar complex is also offering training programs for women for entrepreneurial and agricultural activities and is recruiting women in decision-making roles to guide project activities (African Development Bank [ADB], 2014).

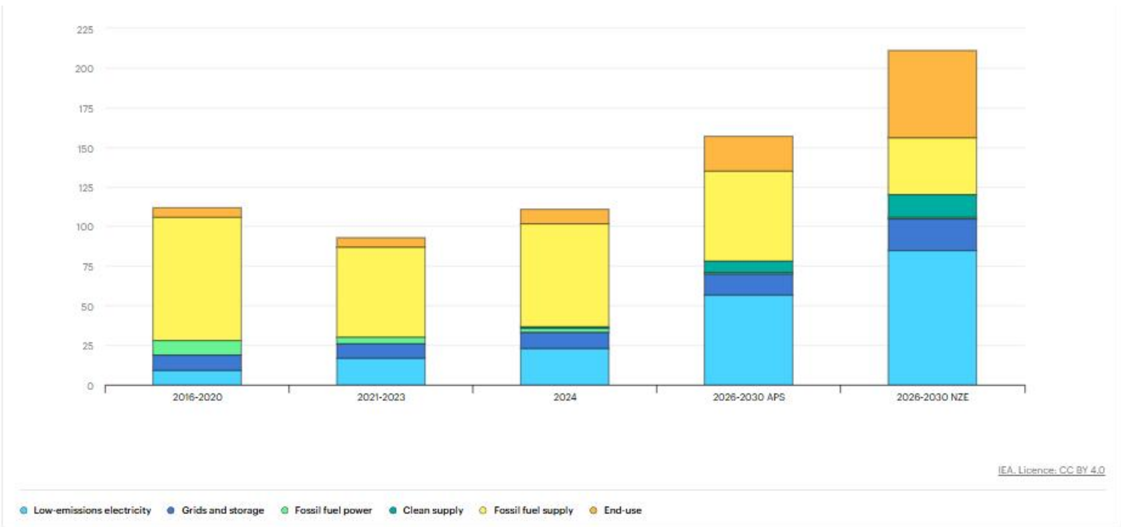
South Africa's Carbon Tax Act which places specific levies on greenhouse gases from fuel combustion and industrial processes and emissions came into effect in June 2019 (Republic of South Africa, 2019). By 2035, the carbon tax could reduce the country's emissions by 33% relative to the baseline (Ntombela, Bohlmann & Kalaba, 2019). Furthermore, South Africa's recent renewable energy auctions have led to solar and wind prices lower than those of the national utility or from new coal plants (Advancing Africa with Renewable Energy Auctions, 2018). Often regarded as the continent's clean energy trailblazer, much of what has been learned through South Africa's renewable energy procurement process can influence similar developments across Africa. Nigeria, which struggles with electricity access for a majority of its population, has set a renewable energy target of 30% by 2030 (Corfee-Morlot, 2019). Natural resource-rich African countries, like Nigeria, should see renewables as a central part of achieving universal energy access while setting themselves on a pathway for low-carbon and resilient development.

The biggest energy companies see this future too and are working to diversify their global portfolios. As of September 2019, the world's major oil companies had made about 70 clean-energy deals, putting them on track to surpass the total for 2018 (Abington & Gilblom, 2019). Shell, for instance, has invested in Solar-Now which sells high-quality solar solutions in Uganda and Kenya. Since its inception in 2011, Solar-Now has supplanted 210,000 tons of greenhouse gas emissions (Solar-Now, 2019). More African countries should insist upon being recipients of this 21st century investment. While the private sector is driving the shift into renewables, state-owned enterprises (SOE) in the energy sector—in Africa and globally—are lagging behind (Dirk Rottgers & Scherrer, 2018). African governments need to support reforms in the SOE sector. For example, by introducing competitive procurement for electricity supply. This strategy could open African institutions and markets to emerging opportunities in the renewable sector, and even drive down the price of renewables (Herscowitz, 2018). Efforts such as South Africa's Renewable Energy Independent Power Producer Procurement (REIPPP) program and the World Bank and International Finance Corporation's Scaling Solar program have resulted in solar prices as low as $0.05/kilowatt-hour.

The amount that countries must pledge to reduce greenhouse gas emissions and deliver on that commitment in the upcoming round of Nationally Determined Contributions (NDCs), are due in early 2025 in preparation for COP30. To meet the 1.5°C target, cuts of 42% must be made by 2030 and 57% by 2035. The globe would be on track to see a temperature increase of 2.6–3.1°C this century if these new NDCs were not made more ambitious and implemented right away. People, the environment, and economies would all suffer greatly as a result (Emissions Gap Report, 2024). Technically, a 1.5°C road is still achievable, and forests, wind, and solar power all hold great potential for rapid and extensive carbon reductions. A whole-of-government approach, policies that optimise socioeconomic and environmental co-benefits, improved international cooperation that includes reforming the global financial architecture, robust private sector action, and at least a six-fold increase in mitigation investment are all necessary to support sufficiently strong NDCs in order to realise this potential. The higher burden would fall on the G20 countries, especially the highest emitters (Emissions Gap Report, 2024).

An estimated USD 110 billion will be invested in energy across Africa in 2024, according to the World Energy Investment (2024) tracking of energy spending. Approximately USD 70 billion will go towards the supply and power of fossil fuels, with the remaining funds going towards a variety of renewable energy technologies. In Africa, where 600 million people lack electricity and around one billion do not have access to clean cooking, energy access is one of the most important issues. The amount of funding needed for energy access programs is far less than the $25 billion needed annually to meet the 2030 goals of universal access to contemporary energy. Concessional finance providers will need to mobilise funding for the most disadvantaged households and assist in the development of bankable projects in order to make progress in this area. To enable the private sector to play a more active role, further de-risking capital will also be essential (World Energy Investment, 2024).

One of the main obstacles to increasing sustainable energy investments in Africa is the high cost of funding. In addition to much greater international financial and technical assistance, national authorities will need to make a huge effort to reduce risks both nationally and specifically for individual projects. This effort will be based on well-defined plans and ambitious NDCs (World Energy Investment, 2024).



nario and in the Net Zero Emissions by 2050 Scenario, 2016-2030

Source: Adopted from World Energy Investment (2024)

2.4 Some Determinants of Economic Growth

Economic growth is influenced either directly or indirectly by a number of classic macroeconomic monetary and fiscal policy variables, including the money supply, inflation rate, budgeting, taxation, interest rates, and exchange rates. However, since environmental degradation factors like CO_2 emissions, fossil fuels, and renewable hydroelectric power consumption, human development, and trade openness have been inextricably linked to economic growth, a sound energy policy becomes essential to achieving desired economic growth and development within a healthy environment (Schroder & Storm, 2018). Other studies that considered this scope include Ejuvbekpokpo (2014); Aye & Edoja (2017); Mesagan (2015); Shahbaz, Nasreen, Ahmed & Hammoudeh (2017) among others. And this is within the scope of this study.

2.4.1 Relationship Between Non-Renewable Energy (NRE) and Economic Growth

Early attempts to spur economic growth have been found to be the root cause of environmental issues because higher output equates to higher pollution levels from carbon emissions from both the manufacturing and consumption of commodities. Nonetheless, others have argued that the relationship between EG and environmental deterioration is more nuanced than previously stated (Cederborg & Snobohm, 2016). According to Dinda (2004), Economic Growth may eventually benefit the environment. In addition to explaining that Nigeria does not accomplish growth in a sustainable manner that satisfies people's present desires without compromising the potential of future generations to attain their desires, Mesagan (2015) suggested that carbon dioxide emissions have an impact on Nigeria's Economic Growth. Oil resources could impede future Economic Growth if sustainable environmental management, such as CO_2 emission abatement and climate change adaption techniques of KYOTO PROTOCOL, are not given first order priority now. Nigeria is regarded as one of the world's top users and producers of FF (Mesagan, 2015).

Odemba (2011) assert that the effect of the global drift from FF is set to downsize Nigerian and other Africa countries economy. In all ramifications, the Kyoto Protocol, if implemented fully, it will dwindle revenue for oil-exporting countries in Africa owing to heavy demand cut for petroleum (as cited in Ejuvbekpokpo, 2014). Moreover, CO_2 has been considered as a major pollutant that contributes about 75% of GHG emissions (Edoja, Aye, & Abu, 2016, Abbasi & Riaz, 2016). One of the most applied emissions in EKC application is CO_2 (Tutulmaz, 2015). In a world of continuous economic development and constant production growth, it is imperative to understand the association between NRE (environmental degradation) and Economic Growth (Cederborg & Snobohm, 2016). Per capita petroleum consumption increased in African oil-producing economies. Of these economies, Angola and Nigeria clearly use the least amount of petroleum (per capita). According to Awodumi and Adewuyi (2020), Gabon is the top consumer of petroleum resources (per capita), followed by Egypt and Algeria. This is in contrast to Gabon (and to a lesser extent, Nigeria), where per capita petroleum consumption decreased during the period under consideration. Economic Growth and non-renewable energy consumption jointly contribute to the observed increase in CO_2 emissions over the study period in Nigeria (Dansofo et al, 2024).

2.4.2 Relationship Between Renewable Energy (RE) and Economic Growth

The perspective of energy system in Africa and the globe must be studied in the face of recent dynamic climate, with respect to renewable energy technology role (Dalla, Longa, & VanderZwaan, 2017). Recently, reducing the level of emissions of CO_2 is a major goal of every country across the globe. This they aim to achieve by switching energy production and cutting their energy consumption. African continent has joined the rest of the world in campaigning and developing RE, joining efforts to mitigate climate change and also encourage the need of reduced carbon economy and spur Economic Growth potentials (Soava, Mehedintu, Sterpu, & Raduteanu, 2018). In the incoming years, the production of RE will continue to rise rapidly, because of the lower cost of production and it is calculated that in 2040 renewable energy will contribute about 70% to Europe and Africa electricity production (Bloomberg NEF, 2022). Renewable energy has the major benefits of energy diversification source, reduction of fossil fuels dependency, new green technology employment in Europe and Africa and greater energy diversity (Gasparatos, Doll, Esteban, Ahmed, & Olang, 2017).

Ozturk (2017). analyzed the nexus between life quality, national income and energy consumption and highlighted the primacy of electricity and its role in final consumption and the role of renewable source in emerging economy final energy consumption. Following numerous evaluation criteria of alternative development of new energy systems, Mardani et al. (2015) stated the benefit and the desire for the transfer of RE technologies in emerging economies. On the link between RE, consumption and Economic Growth, several studies like Aslan (2013), Apergis and Payne (2012, 2011a, 2011b, 2010a, 2010b) and Jardon, Kuik and Tol (2017) analyzed data from vast variety of regions considered either as groups, or individual using certain criteria and their findings have important and serious policy implications for the concerned countries or regions (Zahoor, Mahmood, Rjoub, Olga, Hussain, 2022; Rafiq & Salim, 2011).

Growth in the supply of electricity has slowed. Since 2018, the pace at which new power-generating projects are being added to Africa's grids has decreased. Installed capacity increased by an average of 6.6% per year between 2011 and 2018, but just 3.8% between 2019 and 2021 (Bloomberg NEF, 2022). Although only 1.3% of the world's solar capacity is in Africa, the continent has a wealth of potential for solar energy. 13GW of capacity, or 5.5% of Africa's total, is now available. Morocco, Egypt, and South Africa are responsible for two thirds of the solar capacity. Solar usage is rising despite the low numbers. After five years of stasis, 24 countries installed at least 1MW of solar in 2021, setting a new record. In 2021, solar accounted for the largest share of new capacity added in 11 nations in the area. PV's modular design and sharp equipment price drops over a ten-year period fuelled the technology's adoption and supported sustainable economic growth (Bloomberg NEF, 2022).

2.4.3 Relationship between Human Capital (HCP) and Economic Growth

The role of HCP specialization within the labour market and industrial organization has been of world priority as the global economy is moving into the fourth industrial revolution. International bodies like World Bank (WB) and IMF (International Monetary Fund) recommended human capital development as a reliable strategy to achieve sustainable future especially in African region (Karambakuwa, Ncwadi & Phiri, 2019). Human capital (HCP) is the experience, knowledge and skills sets possess by workers in an economy. Economic values are provided by these skills since productivity can be increased by knowledgeable workforce. The realization that everyone does not possess the same knowledge or skill set is the concept of HCP. More so, investing in citizen's education can improve work quality (Nickolas, 2019).

There is a strong link between human capital and economic growth. HCP influences economic growth by increasing the people skills and knowledge. Since investment in human capital tends to spur productivity, human capital also tends to directly or positively promote economic growth. The government role is imperative in expanding educational level and the skill-set of a country's population. This may take the form of offering free higher education to people because such knowledge makes the people contribute meaningfully to economic growth. HCP is a fundamental factor of technology adoption as allowed by trade openness (Cohen & Levinthal, 1989, Benhabib & Spiegel, 2005). This variable is relevant and within the scope of this study. The effect of HCP is measured and proxy by total primary and secondary enrolment rate.

Economic growth depends on the development of human capital, and the United Nations Development Report (1996) made the case that greater national investment in this field would result in a more equitable distribution of income because education provides access to higherpaying jobs for people from all socioeconomic backgrounds. Through environmental preservation and the better informed and ecologically conscientious use of society's natural resources for the benefit of future generations, human capital development has been demonstrated to have an impact on GDP growth. Because of this awareness, nations all over the world including Nigeria have implemented investments and policies to optimise the advantages of human capital development for their domestic economies. (Ariayefa, Ebimowei & Anda-Owei, 2023). Recently considerable number studies have examined human capital –growth nexus (Tsaurai & Ndou, 2019; Attahir, Ahmad & Abdullahi, 2020; Gruzina, Firsova & Strielkowski, 2021; Olayiwola, Bakare-Aremu & Abiodun, 2021; Ariayefa, Ebimowei & Anda-Owei, 2023).

2.4.4 Relationship between Trade Openness (TOPN) and Economic Growth

Traditional trade theory found that the main ways that trade openness can promote Economic Growth at the national level are through resource allocation, specialisation, and investment in R&D (innovation), which all enhances productivity. In the literature on development, there has been much discussion about the importance of trade policy in economic growth. According to Ricardo's thesis, a country can shift its scarce resources to a better sector with greater efficiency when there is openness among other nations (Zahonogo, 2017). Technology innovation was identified as endogenous by Solow's (1957) neoclassical growth model, which also claimed that trade policies had no effect on Economic Growth. However, new Economic Growth theories contrarily predict technological change as an endogenous factor and trade policies be joined with those on foreign trade. Economic growth can be increased through increase in international trade by facilitating the spread of technology and knowledge from high-tech goods importation (Almeida & Fernandes, 2008). If openness directly influences growth, then liberalization is a required criterion for growth. However, recent empirical experience shows that all trade reforms have not been successful as expected (Singh, 2010; Tyokosu & Abakpa, 2023).

Trade openness promotes the diffusion of innovations and technology to promote economic growth (Oyefabi & Tukur, 2019; Krueger & Berg, 2003; Lucas, 1998), adoption of technology is a function of the country's absorptive capability, which is ascertained by HCP, Research and Development (R&D), financial system development, governance and national institution settings (Fagerberg, 1994, Aghion, Howitt & Mayor-Foulkes, 2005, Haltiwanger, 2011). Unfortunately, emerging economies characterized by insufficient R&D, human capital, undeveloped financial system and poor bureaucracy may not be able to take full advantage of technological transfer. Empirical findings have shown that too many regulations prevent growth because most productive sectors and efficient firms within the sector do not have access to adequate resources needed (Bolaky & Freund, 2008) and the heterogeneity in the trade-growth can be explained by these endemic factors in emerging economies (Sindzingre, 2005).

Fosu (1990), Kim and Lin, (2009), Agenor (2004), Liang (2006), Herzer (2013), Zeren and Ari (2013), Oyefabi and Tukur (2019), Umar, Hawwa, Nazeef and Yahaya (2021) empirically used regression estimation approach which reports a positive relationship between trade openness and economic growth in their studies respectively. While Musa (2020), Sunday and Ahmed (2019), Egbulonu and Adaku (2018), Ulaşan (2015), Trejos and Barboza (2015) empirical studies reported that TOPN is negative, not robustly and significantly associated with Economic Growth. Hence, they concluded that TOPN alone do not spur Economic Growth. Since oil exportation and fossil fuel importation constitute a significant proportion of oil exporting countries foreign exchange earnings in Africa, TOPN becomes a salient variable in the study of this nature.

2.5 Theoretical Literature

Some economic growth theories relevant and related to this study are reviewed and explained below.

2.5.1 Environmental Kuznets Curve (EKC) Theory

Grossman and Krueger (1991) created the EKC theory and model, which the World Bank accepted in 1992 to explain global developmental reports (Stern, 2003). Panayotou dubbed it the EKC in 1993. Examines the relationship between economic growth and sulphur dioxide levels in the air in 47 cities spread across 31 countries. Up to a point where the trend shifts and the inverse association becomes apparent, the EKC model placed an inverted *U* curve relationship between the level of emissions (sulphur dioxide) and economic activity, as measured by per capita income. The same relationship that Kuznets (1955) proposed between EG and income inequality supports the EKC moniker. The EKC theory is hinged on the movement from rural areas agricultural production to urban areas industrial production. Pollution increases due to intensive industrial production. However, the industrial heavy pollution is phased out with time and higher income levels supporting a high technological and service-centralized production, this development will mitigate and drop pollution level. The influence of a high-technological and effective production economy will help to reduce pollution and promote consumers interest for higher clean climate demand and higher political interest in the well-being of the environment (Dinda, 2004). This is further explained diagrammatically;

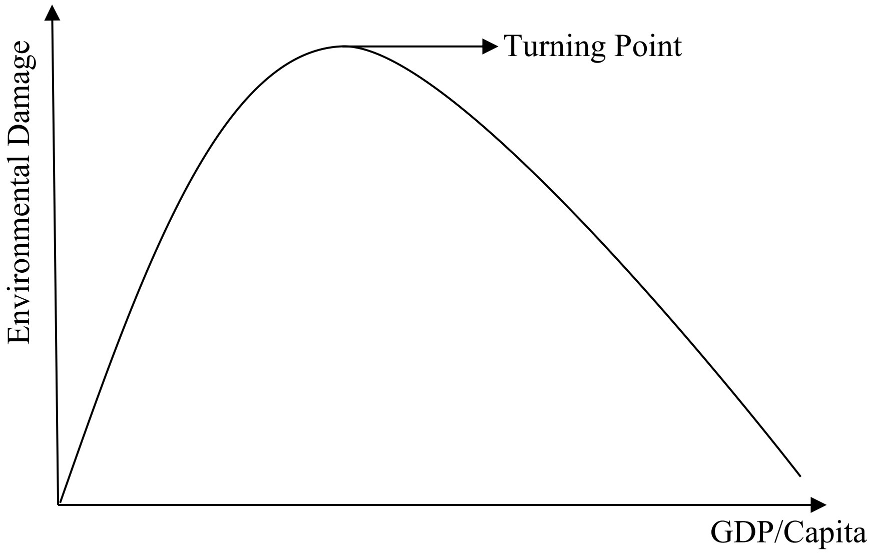


Figure 3: Inverted relationship between emission and economic growth

Source: Adapted from Stern (2004)

Grossman and Krueger (1991) used the scale effect, technological effect and increase demand for clean planet mechanism to explain the EKC shape. First, as economies grow, the early increase in environmental degradation is termed *scale effect*. Growth in economy means increased pollution levels because output has increased. Pollution is expected to rise to scale with economic growth; because more input is needed to increase output and more natural resources are utilized. Thus, pollution level increased (Grossman & Krueger, 1991). The existence of other mechanisms that offset the scale effect is revealed by the EKC shape. The sum of these mechanisms jointly acts as a catalyst that influences environmental degradation as economies grow. The mechanism that reduced the scale effect completely is described as international trade effect, technological effect and composition effect which promote clean environment demand and tight regulations.

Second, *the technological effect* explained the influence of technological advancements and a more efficient and effective production. Environmental concerns on firm-level, is not usually the basis for new technology incentives. Rather, the utilization of a more effective production for environmental benefits. Firms make production cheaper to maximize profits by investing in existing, effective and developing new technology internally. Investment in Research and Development (R&D) can be afforded by richer nations which makes technological advancement move hand in hand with economic development (Komen, Gerking & Folmer, 1997). Efficient production need less input which is expected to exact diminishing influence on pollution levels. A drift from industry-heavy economy to a more service-intensive economy do change the composition of goods and services in that country called *composition effect*.

Third, Increased demand for clean planet have been argued to contribute to decrease in environmental degradation because increase in income and the demand for clean environment have direct relationship up to some point when the demand for clean environment relatively increases above income increase (Roca, 2003). This is expressed in consumer's choice via their preference for less planet damaging products, voting for planet or environmentally damaging parties and donations to environmental organizations. Hettinge, Dasgupta and Wheeler (2000) suggest the strengthening of environmental regulation as a veritable tool to mitigate pollution growth. These environmental regulations include emission standards, charges, property rights and subsidies (Cunningham & Sinclair, 1998). The EKC model was not only restricted to urban areas and sulphur dioxide concentrations but to universal environmental degradation. The empirical support for this generalization is rare in the literature and as a result, many have criticized it (Stern, 2004). Yet, the hypothesis of an inverted *U*-shaped relationship between economic growth and environmental challenges lives on.

Changes in the environment brought about by urbanisation, population growth, and economic expansion, rising energy use, and intensification of agriculture are always at the top of every country's developmental agenda. Climate change and environmental degradation are issues that must be handled globally rather than being limited to a single nation or area. The well-known Environmental Kuznets Curve is one hypothesis that is extensively employed as an empirical model if the emphasis is on the connection between environmental deterioration and economic growth (Leal & Marques, 2022). As a result, economic expansion benefits the environment. However, detractors (critics) believe that there is no assurance that economic expansion would result in a better environment. In fact, the opposite is sometimes true. In order to ensure that economic growth is consistent with an improving environment, at the very least, highly specific policies and attitudes are needed (Figure 4).

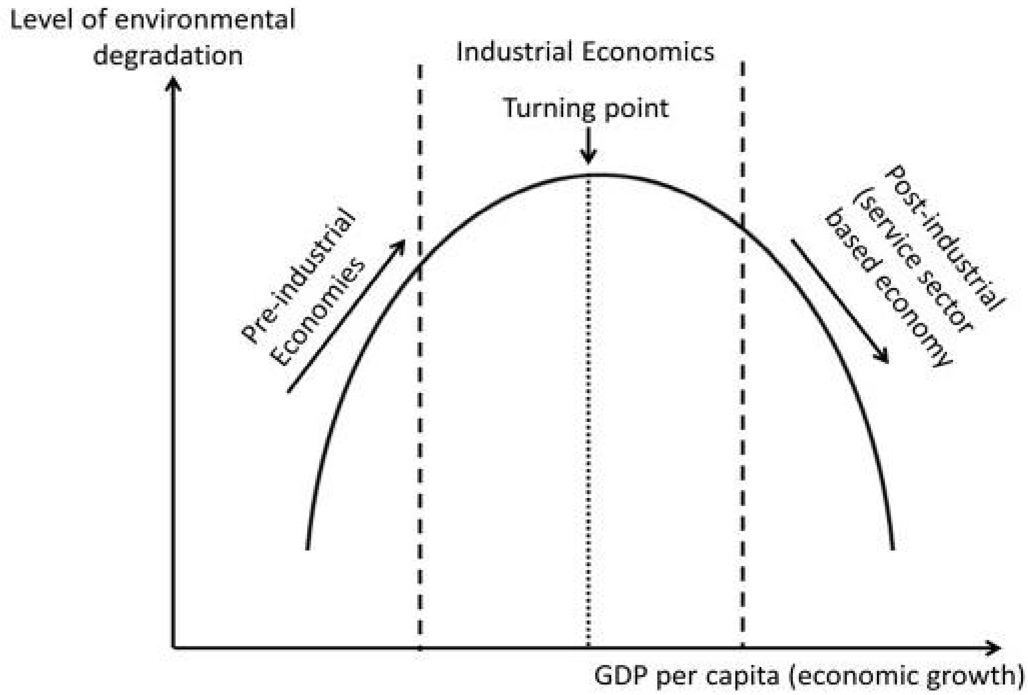


Figure 4: Economic development and Environmental Deterioration

Source: Adopted from Stern (2004)

2.5.2 The Brundtland Curve Hypothesis

Another hypothetical curve used to describe the environmental impact of economic expansion is the Brundtland Report (BR), also known as the World Commission on Environment and Development's ([WCED], 1978) report titled "Our future." The BR offers an opposing viewpoint on the relationship between environmental harm and economic expansion. Brundtland (1978) cited in Cederborg and Snobohm (2016) suggested that poor nations initially caused high degree of environmental degradation, when the economy grows and therefore environmental degradation reduces until a turning point is reached where environmental degradation increases to form a *U*-shaped curve that is contrary to EKC.

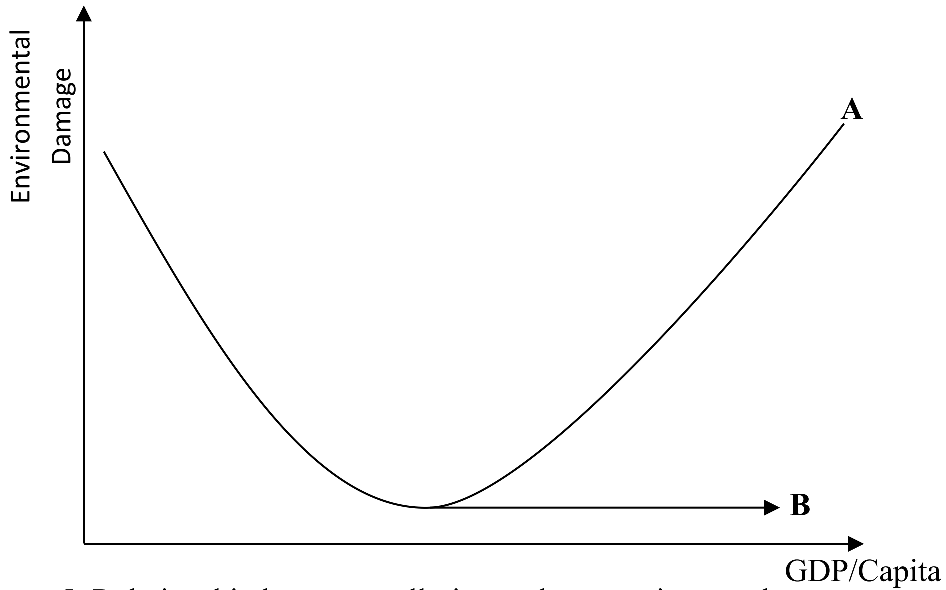


Figure 5: Relationship between pollution and economic growth
Source: Adapted from Cederborg and Snobohm (2016)

Figure 5 X-axis contained GDP Per capita and y-axis is the Environmental Damage (ED). ED level takes a U curve at (A) where the minimum environmental degradation is caused by average (middle) income countries. The alternative path (B) indicates stagnation in environmental degradation level instead of an increase in ED as indicated by the *U* curve (A). Path B (minimum level of environmental degradation) is feasible with high priority of green technology and development. Rich countries could invest in innovative production and green technology investment in order to ameliorate the increasing level of pollution (Bratt, 2012). The Brundtland curve shows that high environmental damage is caused by poor countries owing to their inability to prioritize environmental wellbeing. Increased deforestation and over-exploitation of sensitive land are imperative for citizens residing in high penury to make a living (Larsson, 2011). Upon the attainment of the turning point, pollution is expected to increase with Economic Growth in the same magnitude. This direct trend in ED is in line with Brundtland curve hypothesis occasioned by higher consumption that spurs production.

The ED caused by high production is tantamount to that caused by poverty as submitted by the theory (Field & Field, 2013).

2.5.3 Solow Growth Model

Solow (1956) developed this model to x-ray the role of factor input (capital, labour and technology) in output process. In this process, energy is perceived as a natural resource which becomes an input in production technology (Stern, 2011; Greiner, Gruene & Semmler, 2012; and Stern & Kander, 2012). The mathematical expression of this model as suggested by Wang (2012) is given as;

$$Y=(1-\gamma) K^{\beta} L^{(1-\beta)}+\gamma E, 0<\gamma<1, 0<\beta<1 \quad \ldots\ldots(1)$$

$$K=s(Y-E)-\delta K, 0<s<1, 0<\delta<1 \quad \ldots\ldots(2)$$

Where;

K = capital, L = Labour, γ and β = energy and capital parameters, E = energy, Y = gross output (growth rate of capital stock in investment), s = saving rate, δ= capital depreciation rate over time. Y-E In Eq (2) shows that accumulated capital is adjusted by energy consumption. It is assumed in this model that substitution elasticity between other inputs (labour and capital) and energy is less than one (< 1). This indicates that some minimum quantity of energy is needed and should be combined with other factors input to yield output.

This model was empirically evaluated by Ozturk (2010) and the findings came out with the development of four different hypotheses that explained the nexus between Energy Consumption (EC) and Economic Growth are as follows; a.) EC positively affect output growth rate. This means that the more EC in the production process, the higher the output and therefore Economic Growth increases, this is called the growth hypothesis. b.) The conservative hypothesis suggested in contrast that, EC quantity in a given society is a function of Economic Growth rate. Thus, embracing energy conservation policy will not deter Economic Growth in a country. c.) The feedback hypothesis position that energy consumption level and growth in the economy have a (bidirectional) complete causality relationship. This means that those factors have a simultaneous influence on each other. d.) The neutrality hypothesis is the last, which suggests that there is no causality relationship between EC and Economic Growth indicating that both variables are independent of each other (Ozturk, 2010; Bimanatya & Widodo, 2018).

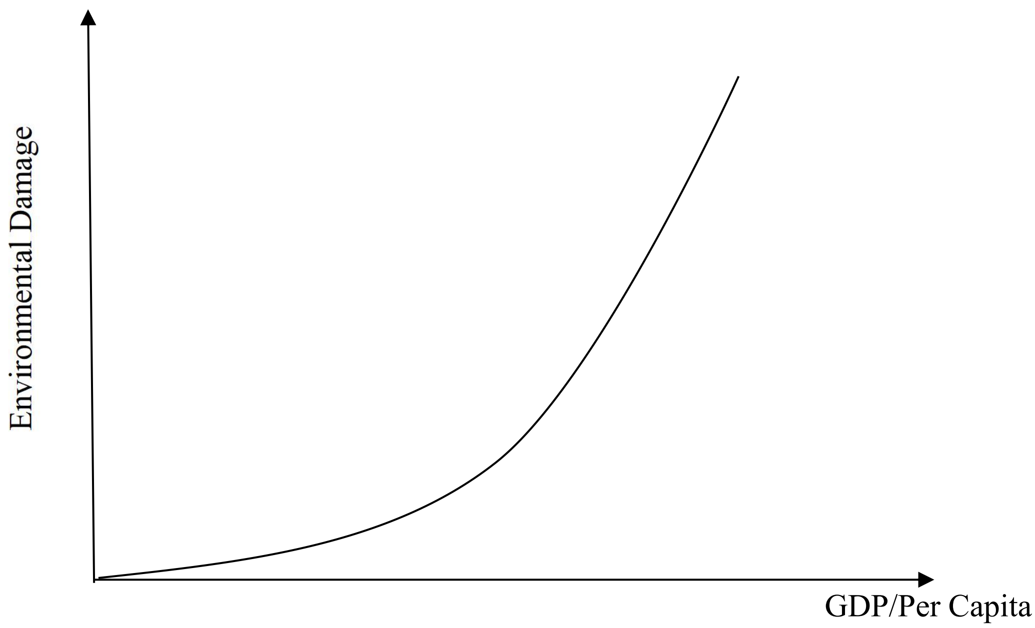
Carbon emissions are considered as different economic activities by-products, which are used to some extent as economic activities indicator. In addition, as an important part of energy-intensive industries and transportation, carbon emissions have a significant influence on economic activities (Alam & Hossain, 2024; Leitão, Ferreira &Santibanez-González, 2022).

2.5.4 The Environmental Daly (ED) Curve Hypothesis

The nexus between ED and economic growth (EG) was described by Daly (1973) in his work "Toward a steady state economy". The ecological economist submitted that, economic growth driven by increased production today is unsafe; and this can be substituted by a steady-state type of economy as an alternative. Human innovation and creativity impact was further questioned by Daly and he positioned that the encouragement for green technology is inadequate to reduce environmental pollutions and damage. Some natural resources are being used at a higher pace than the required quantity to maintain a sustainable quantity, while others are non-renewable.

Put differently, green development is not sufficient to edge out the application of natural resources and ED in totality. Although, when a country attains a specific level of wealth, incentives for a high-quality better environment might surface. However, the damage must have eaten too deep (Daly, 1973). The effort to develop a green production and sustainable consumption will not be effective enough to reduce ED. As the country experience growth increase, environmental degradation and damage will increase no matter the effort of the policy makers and citizens to stop it (Daly & Farley, 2004). Thus, the hypothesis of the Environmental Daly Curve states that higher GDP per capita will result to greater environmental damage. Thus, ED and Economic Growth are directly related due to increased production. Contrary to Brundtland curve and EKC hypothesis, the Daly curve is devoid of any turning point irrespective of any given level of wealth (Brath, 2012).

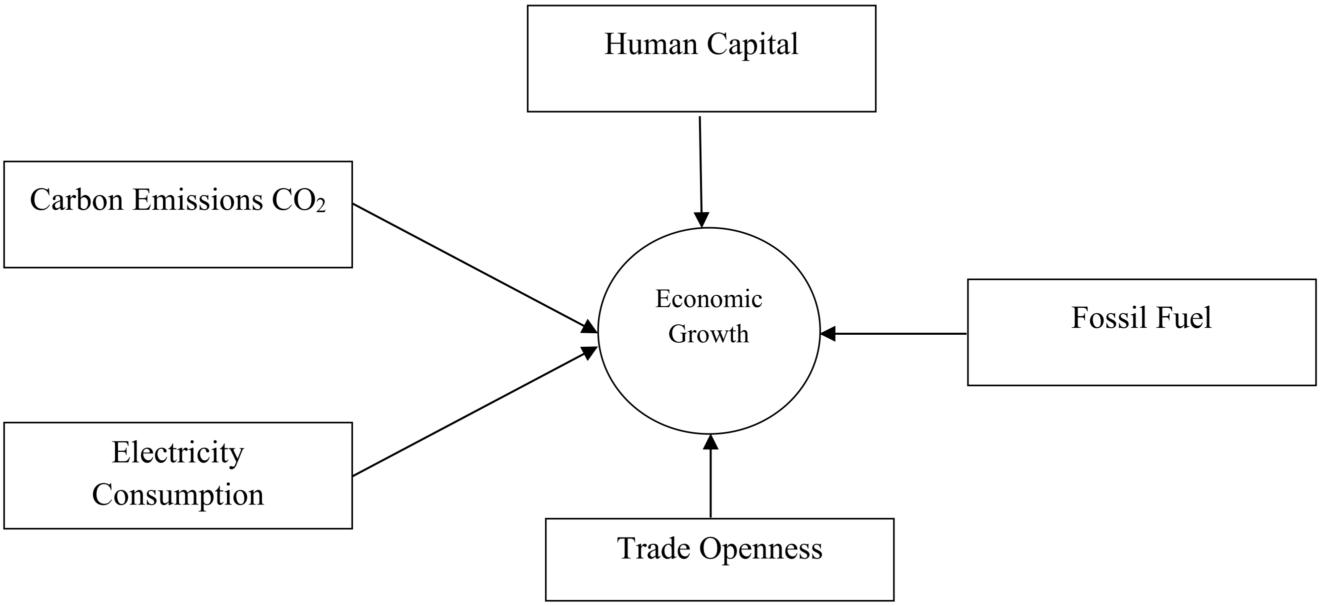
Figure 6: *The Environmental Daly Curve Hypothesis*



Source: Adapted from Cederborg and Snobohm (2016)

The x-axis contains economic growth while y-axis is the environmental damage. The figure 6 indicates direct association between ED and Economic Growth without turning point.

Figure 7: **Schematic Diagram**



Source: Researcher's Conception (2024)

2.6 Empirical Review

Economist and policy makers are seriously concern with energy-growth nexus due to its salient policy implications. This generated various research efforts in both developed and emerging economies to ascertain this position which amounted to different findings. For instance, Chan and Lee (1996) applied the co-integration and the Vector Error Correction model (VECM) method to explain China's way of Energy Consumption (EC). Findings suggested that energy price, income and the share of heavy industry output in national income are significant determinants of EC. Similarly, Cheng (1999) used the Granger Causality (GC) approach to analyse India data set from 1952-1995. The findings indicated that, causality runs from Economic Growth to EC both in the short and long period. The result never detected causal nexus between EC to Economic Growth. Aqeel and Butt (2001) examined the causal association between EC, Economic Growth and employment in Pakistan. Findings show that Economic Growth causes total EC. Wei (2002) studied the long-run association between total EC and some main economic indices like income, energy price and the share of heavy industry in the GDP and realizes that EC and main variables are co-integrated.

On Gulf Cooperation Council (GCC) panel of six countries, Al-Iriani (2006) co-integration approach found that EC and GDP are co-integrated. But contrary to Lee's (2005) findings, who noted that causation runs from real GDP to EC. Akoena and Agyire-Tettey (2007) adopted the Vector Autoregressive (VAR) approach to ascertain the nexus between Economic Growth and EC in Ghana. Result indicates that Economic Growth causes EC proxies by Ghana's petroleum products and electricity consumption. Nguyen-Van (2008) ascertained the nexus between EC and Economic Growth. The study used the semi-parametric panel data analysis and discovered that EC in the emerging nations would increase than expected. More so, Huang, et al. (2008) did not find causality relationship between EC and Economic Growth in low-income category, but found that EC increase is influenced by Economic Growth in middle- and high-income nations. Chang, Huang and Lee (2009) used the panel threshold regression (PTR) model to analyse data from the OECD countries over the period 1997–2006, and discovered that economic growth level of a country influences energy use as a recourse to oil price shocks. Adopting semi-parametric partially linear panel model for 158 countries ranged 1980-2004. Von (2009) discovered that EC positively influences Economic Growth but the impact of time trend is not significant.

Consequently, Ang (2009) found in China that higher income, greater energy used and trade openness increases CO_2 emissions. Zhang and Cheng (2009) in China adopted multivariate causality techniques to establish the findings that causality runs from GDP to EC (CO_2) in the long run. However, CO_2 emissions and EC never leads to Economic Growth during the sample studied. Furthermore, Bartleet and Gounder (2010) used causality technique to investigate the nexus between EC and Economic Growth in New-Zealand using multivariate models. Findings revealed that employment, Economic Growth, and EC have co-integrating relationship. Causality association runs from Economic Growth to EC. Thereby, increase in energy demand is determined by economic activities. Omojolaibi (2010) studied environmental quality and Economic Growth nexus in some selected West African countries to assess the validity of environmental Kuznets curve. The pooled OLS regression approach was adopted and findings of the pooled OLS confirmed the validity of EKC, while the fixed effects estimate were at variance with the EKC applicability in West Africa. Policies that ensure efficiency in energy use should be enacted by countries to CO_2 emissions was recommended by the study.

Li, Dong, Liang and Yang (2011) found a direct long-run link between Economic Growth and EC in China using a sample of 30 provinces considered. In Nigeria, there are two studies that investigated the causality association between EC, Economic Growth, and emission level in Indonesia. Using 1971 to 2007 dataset, Jafari, Othman and Nor (2012) applied Toda-Yamamoto procedures and reported that there is no causality link between variables considered. Using different data stream, Hwang and Yoo (2012) reported a unidirectional relationship from Economic Growth to EC and CO_2. Bi-directional causalities were also detected between EC and CO_2 in the long run. Abouie-Mehrizi, Atashi and Elahi (2012) examined the effect of Economic Growth, population growth and urbanization on CO_2 emissions in Iran from 1973 to 2008. Variables considered were analysed with OLS regression techniques. Findings pointed out that variables considered (urban population, energy use, gross domestic product, population growth and product growth rate positively and significantly influence CO_2 emissions. Seetanah and Vinesh (2012) used OLS regression approach to conduct a study on the nexus between carbon emissions and Economic Growth in Mauritius from 1975 to 2009. Findings suggest CO_2 emissions and GDP time path are closely related and emissions elasticity increased income over time. Finally, the EKC was not *U* shape over the studied period. Hence, in the last three decades Mauritius could not curb its CO_2 emissions.

Granados and Carpintero (2012) examined carbon emissions and Economic Growth relationship from worldview. Long time series for a number of low, high and mid income countries were collected and analyzed with panel data regression techniques. Findings showed that the existence of an EKC for carbon emission is very doubtful. Safdari (2013) investigated the influence of CO_2 on Economic Growth in Iran. The causality test suggests that mutual causality exists between the Iranian Economic Growth and degree of CO_2 emission. Mohammadi and Mohammadi (2013) used data set from 2003 to 2011 to ascertain the causal nexus amidst GDP per capita and petroleum export in 13 OPEC countries. Stable long run association was discovered between both variables as indicated by the co-integration result for all panel members. Finally, a homogenous causality exists between petroleum exports to GDP per capita and vice versa, for all members of the panel was also found.

Shuaibu and Oyinlola (2013) used the Zivot-Andrews unit root test and Gregory-Hansen co-integration test to establish a causal nexus between CO_2 and EC to Economic Growth. Findings show that causal link between both variables were not found because of structural shift. Shabbir, Shahbaz and Zesshan (2014) studied the association between renewable, non-renewable EC, real GDP and CO_2 emissions in Pakistan. Adopting the Structural VAR techniques method, findings show that rising energy is fulfilled with the help of non-renewable and renewable EC in the short term. However, the rise in non-renewable EC promotes real GDP in short-term. Moreover, the CO_2 emissions negatively influence and worsen economic activity, Economic Growth falls but renewable EC largely grows. Olarinde, Martins and Abdulsalam (2014) used the fixed effects panel regression approach to study the correlation between CO_2 emission and Economic Growth for West African countries, and realized an N shape association between income and CO_2 emissions. Also, the EKC hypothesis is not supported for West Africa. Ayadi (2014) investigated the relationship between economic integration, growth and the environment in Africa using Nigeria as a case study. The OLS regression suggested that economic integration significantly influence output based on the economies of scale property and technology exchange. While trade and foreign direct investment (FDI) were identified as the two major channels through which integration affects growth. Both economic growth and FDI into Nigeria significantly spur pollution while trade is beneficial both in the short and long run.

Chen and Huang (2014) studied the nexus between CO_2 and Economic Growth for 36 countries using time series data from 1985–2012 and the Panel Smooth Transition Regression (PSTR). The findings revealed a non-linear association switched across countries depending on the lagged GDP per capita differential during vary regimes. Ejuvbekpokpo (2014) looked at the influence of CO_2 on Economic Growth in Nigeria. The study used the OLS regression estimate to analyse the time series data ranging 1980-2010 sourced from the central Bank of Nigeria (CBN) statistical bulletin. He found that carbon emissions have negative effect on Economic Growth in Nigeria. In Association of South East Asian Nations (ASEAN) countries, Heidari, TuranKatircioglu, and Saeidpour (2015) studied the correlation between CO_2, EG, and EC in five countries adopting data from 1980 to 2008 using the PSTR model. They found that ED rises with Economic Growth while the trend was reversed in the lagged regime, while energy usage spurs CO_2 emissions in both regimes. Hence, the EKC proposition is supported in the ASEAN countries.

Saidi and Hammami (2015) applied the Generalized Method of Moments (GMM) to ascertain the influence of Economic Growth and CO_2 emissions on EC for a global panel of 58 countries for the period 1990–2012. The results indicate significant positive impact of CO_2

emissions and Economic Growth on EC for the four global panels. Al-mulali, Tang and Ozturk (2015) examined the influence of renewable EC, Economic Growth and financial development on CO_2 emissions in 18 Latin America and Caribbean countries from 1980–2010. The Kao co integration test results show that the variables converge in the long run. And the Fully Modified OLS (FMOLS) model, suggested an inverted *U*-shape link between CO_2 and Economic Growth. Salahuddin, Gow and Ozturk (2015) adopted the dynamic fixed effect (DFE), FMOLS and the Dynamic Ordinary Least Squares (DOLS) models to analyse the nexus between CO_2 emissions, electricity consumption, EG and financial development. Panel data for the period of 1980–2012 of six Gulf Cooperation Council (GCC) countries were analysed to ascertain the long run association between the variables. Findings point out that long run positive link is exacted by electricity consumption and EG on CO_2 emissions while financial development had significant inverse relationship. Kasman and Duman (2015) used panel stationarity tests, panel co-integration test, and panel causality tests based on panel ECM to examine the causal link between CO_2 emissions, EC, trade openness (TOPN), Economic Growth and urbanization for a panel of 15 new EU member and candidate countries over the period 1992 to 2010. Their findings confirmed and support the EKC hypothesis.

Mesagan (2015) assessed nexus between CO_2 and Economic Growth in Nigeria from 1970 to 2013. The study employed capital investment, CO_2 emissions, real GDP, and TOPN analyzed with ECM techniques, the result showed clearly that in the current period, Economic Growth positively influence CO_2, while it negatively influence CO_2 emissions in the lagged period. It also revealed that TOPN and capital investment positively impact CO_2 emission in Nigeria. Kaise and Sami (2015) examined the influence of Economic Growth and CO_2 emissions on EC for a global panel of 58 countries. The study adopted the dynamic panel data model estimated via GMM from 1990 to 2012. They also estimated this correlation for three (3) regional panels corresponding from, North Asia and Europe, Sub-Saharan, Latin America and Caribbean, Middle Eastern and North African. Findings indicate significant direct influence of CO_2 emissions on EC for four global panels. Economic Growth has a direct effect on EC and statistically significant only for the four panel. Cederborg and Snobohm (2016) investigated the correlation between per capita GDP and per capita CO_2 in order to observe the possible influence of economic growth on ED. The study used cross sectional data of 69 industrial countries as well as 45 poor countries. Findings show that relationship between Economic Growth and ED exists and it is positive. However, the EKC hypothesis was not confirmed in this study because no turning point is found as noted by some theories.

Magazzino (2016) used the Vector Autoregressive (VAR) approach to examine the association between CO_2 emissions, Economic Growth, and energy used from 1971 to 2006 for 10 Middle East countries. Result indicates that economic growth negatively responded to carbon emissions as indicated by both the impulse response functions and the coefficient estimated that are negative for the six (6) GCC countries. However, energy used and lagged values seems to be driven by CO_2. But neither CO_2 emissions nor energy used exact significant influence on Economic Growth, which is determined by its own lagged values. Asici and Acar (2016) examined the link between income growth and relocation of ecological footprint in 116 countries from 2004 to 2008. The study adopted the panel regression techniques and detected the *U*-shape EKC-type link only between per capita income and domestic production CO_2. Thus, the findings suggest environmental regulations importance and provide support for the "Pollution Haven" and "Race-to-the-Bottom" hypotheses. Alege, Adediran, and Ogundipe (2016) examined the causal link between CO_2 emissions, EC and Economic Growth in Nigeria from 1970 to 2013 based on time series data. Johansen co-integration, normalize long run estimates and granger causality test methodology were adopted and findings indicate that fossil fuel increases carbon emissions while, renewable energy (electricity) reduce the atmospheric concentration of CO_2 emissions. Causality runs from fossil fuel to CO_2 emissions and GDP per capita in a unidirectional manner. Consequently, clean energy source (electricity power) was found to cause more proportionate change in GDP per capita and causality link between electric power and CO_2 could not be established.

Kais and Ben Mbarek (2017) studied the causal link between CO_2 emissions, EC and Economic Growth countries selected in North African based on panel data spanning 1980–2012. Panel co-integration and VECM techniques was used and they noticed interdependence long run relationship between EC and Economic Growth. Results based on panel VECM observed unidirectional association from Economic Growth to EC, CO_2 emission, and a unidirectional causal relationship from EC to CO_2 emissions. Antonakakis, Chatziantoniou and Filis (2017) used VAR method to consider the nexus between EC per capita CO_2 emissions and Economic Growth for the period 1971 - 2011. Result showed heterogeneous effect of vary kind of EC on emissions and Economic Growth in various countries group. Also, feedback hypothesis was supported via the bidirectional causality between total Economic Growth and EC. Finally, evidence in support of the EKC hypothesis was not found and renewable EC had no significant influence on Economic Growth.

The correlation between EC, CO_2 emission, TOPN, income and population using data from five selected countries of South Asia spanning 1971 to 2013 were explored by Ahmed, Rehman, and Ozturk (2017). The panel co-integration test and FMOLS indicate co-integrating relationship, and that TOPN and increase in environmental degradation has negative impact. Also, partial causality was run from TOPN, EC and population to CO_2 and not the other way. Uddin, Salahuddin, Alam and Gow (2017) explored the influence of TOPN, real income and financial development on the Ecological Footprint (EF) of sampled

27 countries with the highest level of CO_2 emissions from 1991–2012. The panel co-integration test and the Dynamic OLS (DOLS) methodology were adopted. Findings reveal the following; long run significant direct association between real income and EF, negative but non-significant influence of TOPN, financial development on EF. These findings were also confirmed by the FMOLS approach and the VECM outcome confirms that partial (unidirectional) causality runs from real income to EF. Variance decomposition analysis and impulse response functions suggested that real income will have an increasing influence on EF into the future. Jardon, Kuik and Tol (2017) x-rayed the nexus between CO_2 emissions and Economic Growth in a panel of 20 Latin American and Caribbean countries spanning 1971-2011 period. The study used recent unit root test and co-integration. Findings confirmed the existence of EKC hypothesis with realistic turning point. However, the EKC was later rejected because due to the presence of cross-dependence in the panel and long run equilibrium relationship were not detected.

Shahbaz, Nasreen, Ahmed, and Hammoudeh (2017) applied the panel co-integration (Pedroni and Westerlund) tests to examine the association between TOPN and CO_2 emissions and Economic Growth as supporting variable. 105 data stream for middle high and low income nations from 1980 to 2014 were analysed. The findings show that the variables considered are co-integrated. TOPN deters environmental quality but the impact is different in various groups of countries. The VECM causality indicates a causality effect between TOPN and CO_2 emissions globally and the middle-income countries but causality runs from TOPN to CO_2 emissions for the low and high-income countries. Using data covering 1975-2007 for 15 MENA (Middle East and North African) countries and applying the panel co-integration, VECM Granger causality framework Charfeddine and Mrabet (2017) explored the validity of EKC hypothesis. Findings show that the use of energy increases Ecological Footprint (EF), while in oil exporting and sample as a whole, GDP per capita exhibit an inverted U-shaped relationship with EF. The *U*-shape nexus is confirmed between EF and economic growth, thus EKC not supported. Except for political institution, the environment in the long run is improved by life expectancy, fertility rate and urbanization.

Aye and Edoja (2017) explored the influence of EG on CO_2 in 31 emerging economies. The dynamic panel threshold framework was adopted to analyse the panel data and the result found that Economic Growth negatively influence CO_2 emission in low growth era and direct influence in high growth era. Thus, lending no support to the EKC hypothesis; instead, the *U*-shaped correlation is detected. Also, population and energy consumption directly influenced CO_2 emissions. The EKC position was not changed in the study with the inclusion of financial development indicator. Evidence of causal links between the variables of interest was not found. Hence, the need for transformation of low CO_2 technologies aimed at reducing emissions and promoting sustainable Economic Growth that may include energy efficiency and switch away from non-renewable energy to renewable energy was strongly recommended. Using data for 28 countries of European Union, Soava, Mehedintu, Sterpu, and Raduteanu (2018) studied the causal link between Economic Growth, and renewable EC. Various panel data regression model were used and the findings revealed a positive influence of renewable EC on Economic Growth. For each country panel, partial (unidirectional) causal link was established between the two macroeconomic elements for each nation in the sample.

Olubusoye and Dasauki (2018) tested the EKC hypothesis in 20 African countries grouped into; Upper-Middle, lower- Middle and Low-income African economies. Using short and long-run income elasticity method, the study found inverted *U*-shaped because long-run income elasticity is smaller than short-run income elasticity. This means that, carbon emissions reduces as income increases over time in 30% of the sample and low-income African countries. Bimanatya and Widodo (2018) studied the association between fossil fuel consumption, CO_2 emissions, and Economic Growth as well as the projection of energy mix in Indonesia. The study applied the VECM granger causality, and Long-run Energy Alternatives Planning (LEAP) techniques. Findings show that causality runs in a unidirectional manner from CO_2 to Economic Growth and from Oil Consumption (OC) to (conservative hypothesis) in the short run. The results further revealed a unidirectional causal nexus from OC to EC and CO_2 emissions. LEAP projection has lower saving energy rate of 17.32% based on national master plan when compared to 18% target of vision 25/25.

Sarwar, Alsaggaf and Tingqiu (2019) investigated the association between education, health issues, Economic Growth, and CO_2 emissions for the panel of 161 nations. The panel regression estimate shows that health and education exact an insignificant influence on Economic Growth and CO_2. This means that better health conditions and higher education is not a useful tool for preventing environmental degradation process and promoting economic development. Increased capital investment spur economic process and CO_2 and health issues are best controlled by capital investment and higher educational standard in the long and immediate period. On the contrary, increased CO_2 emission creates health issues. Ahmad, Majeed and Andlib (2019) studied the influence of tourism, EC and gross capita formation on GDP for some South Asian nations spanning 1995 to 2016. The FMOLS was applied in the study and they found that tourism is directly related with Economic Growth in the selected nations. Thus, supporting the tourism led growth hypothesis in these countries. Other results show that EC and total capital formation positively influence gross domestic product. Randelovic and Zdravkovic (2019) ascertained the long-run correlation between Gross Fixed Capital Formation (GFCF), real GDP per capita, FDI inflow, value added, energy use per capita, industry and CO_2 emissions in a panel of six CIVETS countries (Colombia, Indonesia, Viet Nam, Egypt, Turkey and South Africa from 1989 -2016. The panel co-integration and Causality techniques were applied and the findings confirmed long run bidirectional association between most variables considered except between, CO_2 emissions and GDP and CO_2 emissions and GFCF.

From historical perspective, Balcilar, Ozdemir, Tunçsiper and Shahbaz (2019) examined the correlation between CO_2 emissions, EC and Economic Growth in the G-7 countries. The historical decomposition method was applied in the study and they discovered that Japan, part of US, Canada and Italy, most trade-off economic growth if CO_2 emissions must be reduced by decreasing fossil-based energy use. However, the EKC position was not confirmed for Germany and the UK. Economic Growth has no negative effect on environmental quality. Also, this influence was cyclical for the USA. Akadiri, Bekun, Taheri and Akadiri (2019) primarily explored the causal association between CO_2, EC, and Economic Growth in Iraq. The bounds test co-integration and Toda-Yamamoto Granger causality approach were applied using dataset covering 1972 to 2013 due to data availability. Findings suggest unidirectional causality moving from Economic Growth to EC and from CO_2 emissions to EC in the long-run without feedback effect between the variables considered in Iraq. Chun and Xiaoxin (2019) used regression technique to maintain that financial development significantly affects CO_2 emissions in emerging economies and least developed countries. Khan, Khan and Rehan (2020) studied the link between economic growth, EC, and CO_2 emissions in Pakistan from 1965 to 2015 the ARDL approach was adopted. Findings indicate that EC and Economic Growth increase the CO_2 emissions in Pakistan both immediate and long run period.

Osadume and Edih (2021) examined economic growth and carbon emissions in selected West Africa countries; using annual secondary data from 1980 to 2019. The panel regression statistical technique was adopted. Report shows that economic growth significantly and positively spurs carbon emissions during the studied short run period. Zhang (2023) looked at the association between CO_2 emissions and economic development in different countries from using historical data from1990 to 2020. The researcher adopted correlation techniques and findings show that there is significant symbiotic interplay between carbon emissions and economic ascension during the studied period. Elom et al (2024) used panel data covering 19 years and five rigorous regression model and technique to evaluate the influence of employment, consumption of renewable energy and education on carbon emissions in thirty-two (32) African countries. Report indicates that the aforementioned explanatory variables have significant inverse relationship with carbon emission. This implies that investment increase in these variables will reduce carbon emission in the region.

Table 2.1 Summary of Empirical Literature

S/N	Authors	Title	Country/Region	Methodology	Main Findings
1.	Chan and Lee (1996)	Energy consumption behaviour	China	VECM	Energy price, income and heavy industry output share are significant determinants in EC.
2.	Cheng (1999)	EC and EG	India	Granger Causality Approach (GCA)	Nexus runs from EG to EC, not the other way.
3.	Aqeel and Butt (2001)	The link between EC, EG and employment	Pakistan	GCA	EG causes total EC was established.
4	Wei (2002)	EC and economic factors of income, energy price, and heavy industry output share	China	Co-integration technique	Co-integrating relationship was established.
5.	Al-Iriani(2006)	EC and GDP	GCC	Co-integration and Causality Techniques	Co-integrating relationship was confirmed between both variables.
6.	Akoena and Agyire-Tettey (2007)	EG and EC	Ghana	Vector Autoregressive (VAR)	EG Granger cause EC

				approach	
7.	Nguyen-Van (2008)	“”	Panel of Developing Countries	Semi-parametric panel data estimation	EC would rapidly rise than expected in developing nations.
8.	Huang, et al. (2008)	Energy use and EG	82 Countries	GCA	Causality between EC and EG was not found in low-income group. But present in middle- and high-income group nations.
9.	Chang, Huang and Lee (2009)	EG and EC.	OECD	Panel Threshold Regression (PTR) model	Economic growth level influences energy use.
10.	Von (2009)	EC and EG	158 Countries	Semi-parametric partially linear panel model	Energy consumption positively influences economic growth.
11.	Ang (2009)	Energy, income, trade openness and carbon emissions relationship	China	OLS regression techniques	Increase in all the explanatory variables considered increased carbon emissions in China
12.	Zhang and Cheng (2009)	CO_2, EC and GDP relationship	China	Multivariate Causality Techniques	CO_2 emissions and EC never leads to economic growth
13.	Bartleet and Gounder (2010)	EC and EG	New Zealand	Granger causality technique	Causality nexus runs from EG to EC.
14.	Omojolaibi (2010)	Environmental quality and EG	West African Countries	The pooled OLS regression approach	EKC hypothesis is supported. Fixed effect estimate was at variance with EKC applicability.
15.	Li, Dong, Liang and Yang (2011)	EG and EC	China	Co-integration techniques	Long run association between EG and EC was established.
16.	Jafari,Othman and Nor (2012)	EC, EG, and emission level	Nigeria	Causality procedures	Causality association was not detected between variables
17.	Hwang and Yoo (2012)	Energy consumption,	Indonesia	Granger causality test	Unidirectional relationship from

		CO_2emissions, and economic growth			economic growth to energy consumption and carbon emission.
18.	Abouie-Mehrizi, Atashi and Elahi (2012)	Population growth, urbanization, EG and CO_2emissions	Iran	OLS regression techniques	All variables considered significantly influence carbon emissions.
19.	Seetanah and Vinesh (2012)	CO_2 emissions and EG	Mauritius	“”	Emissions of CO_2 and GDP time path are closely related. However, the EKC hypothesis was not detected.
20.	Granados and Carpintero (2012)	Carbon emissions and economic growth	Global Perspective	Panel data regression techniques	The existence of an EKC for carbon emission is very doubtful
21.	Safdari (2013)	Carbon emission on economic growth	Iran	Granger Causality Test	Economic growth and carbon emission level displayed mutual causality relationship.
22.	Mohammadi and Mohammadi (2013)	Petroleum exports and GDP per capita	13 OPEC nations	Panel co-integration and Causality approach	Long run relationship and homogenous causality from value of petroleum export to GDP per capita and vice versa
23.	Shuaibu and Oyinlola (2013)	Carbon emission and energy consumption to growth	Nigeria	Zivot-Andrews unit root test and Gregory-Hansen co-integration	Due to structural shift, causal link between both variables were not found.
24.	Shabbir, Shahbaz and Zesshan (2014)	Renewable, non-renewable, real GDP and CO_2	Pakistan	Structural VAR approach	Rise in non-renewable EC promote real GDP in short-term and CO_2 emissions negatively influence and worsen EG
25.	Olarinde,	CO_2 emission		Fixed effects	N shape

	Martins and Abdulsalam (2014)	and economic growth	West Africa Countries	panel regression approach	association between income and CO_2 emissions was confirmed
26.	Ayadi (2014)	Economic integration, growth and the environment	Nigeria	OLS regression	Both economic growth and FDI into Nigeria significantly spur pollution and environmental degradation
27.	Chen and Huang (2014)	CO_2 per capita and EG	36 Countries	PSTR (Panel Smooth Transition Regression)	Nonlinear relationship switched across countries was confirmed
28.	Ejuvbekpokp o (2014)	The CO_2emissions on EG	Nigeria	OLS regression estimate	CO_2 emissions negative effect on EG was confirmed in Nigeria.
29.	Heidari, TuranKatirci oglu, and Saeidpour (2015)	Correlation between CO_2, economic growth and energy consumption	Five ASEAN countries	PSTR	EKC proposition is supported in sampled countries
30.	Saidi and Hammami (2015)	EG and CO_2 emissions on EC	Global panel of 58 countries	GMM	Significant positive impact of CO_2 emissions and EG on EC in the sample was established.
31.	Al-mulali, Tang and Ozturk (2015)	Renewable EC, EG, financial development, and CO_2	18 Latin American and Caribbean	FMOLS technique	An inverted *U*-shape nexus between CO_2 and GDP was confirmed
32.	Salahuddin, Gow and Ozturk (2015)	CO_2 emissions, electricity consumption, EG and financial development relationship.	6 GCC countries	dynamic fixed effect (DFE), FMOLS and the Dynamic Ordinary Least Squares (DOLS) models	Long run positive association is exacted by electricity consumption and EG on CO_2release.
33.	Kasman and Duman (2015)	CO_2 emissions, energy consumption, trade	15 European Union (EU) Members	Panel error correction model	Findings confirmed the support of the EKC hypothesis

		openness, economic growth and urbanization			
34.	Mesagan (2015)	CO_2 and economic growth	Nigeria	Error Correction Model (ECM)	Economic growth positively influences carbon emission in the current period, and reverse was the case in the lagged period.
35.	Kaise and Sami (2015)	EG, CO_2 emissions, and EC	58 countries	System GMM	EG has a direct effect on EC and statistically significant only for the 4 panel
36.	Cederborg and Snobohm (2016)	Per capita GDP, per capita CO_2, and EG	69 industrial and 45 poor countries	Panel regression techniques	The EKC hypothesis was not confirmed in this study.
37.	Magazzino (2016)	CO_2 emissions, EG, and EC	10 Middle East Countries	Vector Autoregressive (VAR) approach	Economic growth negatively responded to carbon emissions. Neither CO_2 emissions nor EC seems to have influence on EG
38.	Asici and Acar (2016)	Income growth and relocation of ecological footprint	116 countries	Panel regression techniques	The U-shape EKC-type relationship was detected
39.	Alege, Adediran, and Ogundipe (2016)	CO_2 emissions, EC, and EG	Nigeria	Johansen co-integration, and granger causality techniques	Causality runs from fossil fuel to CO_2 emissions and EG in a unidirectional order.
40.	Kais and Ben Mbarek (2017)	Carbon dioxide (CO_2) emissions, energy consumption and economic growth	North African	VECM techniques	Unidirectional association from EG to EC, CO_2 emission,
41.	Antonakakis,	EC, CO_2			Heterogeneous

	Chatziantoniou and Filis (2017)	emissions, and EG	106 Countries	Panel VAR techniques	effect of vary kind of EC on emissions and EG in various countries group was confirmed. But EKC evidence was not found
42.	Ahmed, Rehman, and Ozturk (2017)	Energy consumption, CO_2 emission, trade openness, income and population	South Asia	The panel co-integration test and FMOLS	Partial causality is runs from TOP, EC and population to CO_2 emission and not the other way.
43.	Uddin, Salahuddin, Alam and Gow (2017)	TOP, real income and financial development on the Ecological Footprint	27 highest emitting countries	Dynamic OLS (DOLS), FMOLS and VECM	Partial (unidirectional) causality runs from real income to ecological footprint.
44.	Jardon, Kuik and Tol (2017)	carbon dioxide (CO_2) emissions and EG relationship	20 Latin American and Caribbean countries	co-integration techniques	EKC hypothesis was rejected
45.	Shahbaz, Nasreen, Ahmed, and Hammoudeh (2017)	TOP and CO_2 emissions and EG	105 high-, middle- and low-income countries	panel co-integration techniques and VECM	Causality runs from TOP to CO_2 emissions for the low- and high-income countries
46.	Charfeddine and Mrabet (2017)	Economic development, social-political factors and EF	15 MENA nations	Panel co-integration, VECM Granger causality framework	The U-shape nexus is confirmed between EF and EG and EKC hypothesis is rejected.
47.	Aye and Edoja (2017)	Economic Growth (EG) and carbon emission (CO_2)	31emerging economies	Dynamic panel threshold framework	No support for the EKC hypothesis
48.	Soava, Mehedintu, SterpuandRaduteanu(2018)	EG and renewable EC	28 European Union countries	Panel data regression	Direct influence of renewable EC on EG was confirmed.
49.	Olubusoye and Dasauki	CO_2 emissions and	20 African	Short-run and long-run	Presence of inverted *U*-shaped

	(2018)	EG	countries	income elasticity approach	was confirmed
50.	Bimanatya andWidodo (2018)	Fossil fuel consumption, CO_2emissions and EG	Indonesia	VECM and Long-run Energy Alternatives Planning (LEAP) approach	Causality runs from CO_2 to EG and from OC to EG in the short run.
51.	Sarwar, Alsaggaf andTingqiu (2019)	Education, health issues, EG, and CO_2 emissions	Panel of 161 countries	Panel regression technique	Health and education exact a non-significant influence on EG and CO_2
52.	Ahmad, Majeed and Andlib (2019)	Tourism led growth hypothesis: Empirical evidence	South Asia countries	FMOLS	Energy consumption and total capital formation positively influence economic growth
53.	Randelovic and Zdravkovic (2019)	EG and CO_2emissions	CIVETS countries	Co-integration and Causality techniques	Bidirectional long-run causal relationship between all the variables
54.	Balcilar, Ozdemir, Tunçsiper and Shahbaz (2019)	The nexus among CO_2emissions , EC and EG	G-7 Countries	Historical decompositio n method	EKC postulations was not confirmed in Germany and UK
55.	Akadiri, Bekun, Taheri and Akadiri (2019)	CO_2, EC and EG: A causality evidence	Iraq	Bounds test co-integration and Causality approach	Unidirectional causality runs from EG to EC
56.	Chun and Xiaoxin (2019)	Financial development and CO_2 emission	China	OLS regression approach	Both in emerging and least developed economy, financial development significantly spur CO_2 emissions
57.	Khan, Khan and Rehan (2020)	Nexus between EC, EG and CO_2 pollutions	Pakistan	ARDL Approach	EC and EG increase the CO_2 emissions in Pakistan in both immediate and long run.

58.	Osadume and Edih (2021)	economic growth and carbon emissions	West Africa countries	Panel regression method	Positive and meaningful relationship exist between EG and CO_2 emissions.
59.	Zhang (2023)	CO_2 emissions and economic development	China, Indian, United States, United Kingdom and Switzerland	Correlation analysis	Interplay exist between CO2 emissions and growth in economic development.
60	Elom et al (2024)	Employment, consumption of renewable energy and education effect on carbon emissions	32 African countries	Panel regression techniques	The independent variables considered significantly reduced CO_2 emissions during the period.

Source: Researcher's Compilation (2024)

2.7 Gap in Empirical Literature

From existing studies reviewed, findings are mixed even for studies that adopted similar methodology. Variables difference, panel of countries studied, transformation made and sample periods could be responsible for these assorted findings. Easily, it can be observed that most of the cross-country studies tested the influence of Economic Growth on CO_2 and not the other way. They applied panel least square, VAR and VECM Granger causality framework. Apart from the study of Olubusoye, et al (2018), Osadume and Edih (2021) that was cross country in nature on the effect of CO_2 and Economic Growth, the study that tested the EKC hypothesis or Environmental Daly Curve (EDC) Hypothesis of CO_2 emission and Economic Growth nexus among the five (5) largest oil producing countries in Africa was not found. Furthermore, the study that used quarterly time series and panel data and the Error Correction Model (ECM) framework to test the EKC hypothesis or its counter theory of Environmental Daly Curve (EDC) for specific country analysis in the sample considered. Also, the use of high frequency data (quarterly panel data) and panel Vector Error Correction Model (VECM) techniques to test the validity of EKC and EDC hypothesis for all sampled countries considered was not found in the literature to the best of my knowledge; hence, scope and methodological gap in knowledge exist in the literature to be bridged. Therefore, it is on the basis of those gaps identified; including the visible mixed and inconclusive findings in the empirical literature makes it germane to further examine carbon footprint and economic growth nexus in selected African countries.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The objective of this chapter is to outline the procedure the researcher used in this study. This encompasses the research design, data collection, population and sampling techniques, data source, method of data analysis, the theoretical framework, model specification, and operationalization of the variables.

3.2 Research Design

The longitudinal and latitudinal survey research design which is a subtype of ex-post-facto research design is applied in this study. This type of research design best suits a study of this nature because the underlying variables are historical in nature and cut across a number of countries.

3.3 Population and Sample

The entire sixteen (16) oil producing countries in the African continent constitute the population of this study. This study adopted the filtering technique to select the five (5) largest oil producing countries in Africa as ranked by the U.S Energy Information Administration database [EIA, (2023)] and Organization of Petroleum Exporting Countries [OPEC, (2023)]. The selected countries are informed due to the high level of industrial activities which typified them as high emitters of CO_2 emission. Also, they are likely to be the foremost countries to exceed the maximum threshold of 1.5^{o}C CO_2 emission that is detrimental to climate change in Africa. On the basis of the criterion the selected countries are; Nigeria, Angola, Algeria, Libya, and Egypt. Hence, the five (5) selected countries constitute the sample of this study.

3.4 Type and Source of Data

This study predominantly used a combination of quarterly time series data and quarterly panel data. First each country's analysis is based on time series data to test the validity of the EKC and EDC hypothesis for the aggregate sample analysis is based on panel data. Panel data is informed because it contains both time series and cross-sectional data properties which help to reduce the multi-colinearity problem among variables. Also, it gives more variable informative data and more degree of freedom hence more efficiency (Hsiao, 1985; Klevmarken, 1989; & Solon, 1989). Furthermore, all data was sourced from World Bank Development Index (WBDI) database on annual basis and were further calibrated to quarterly data with E-views 10.0 to allow for more observations large enough to cater for degree of freedom. Also, high frequency data are required for ARDL ECM and panel VECM approach to produce a more reliable and efficient estimate for both the country specific and aggregate sample analysis. The variables that was used in this study are; economic growth, carbon emissions (CO_2), fossil fuel, trade openness, electricity consumption, and human capital from 1980 to 2023. Five (5) countries formed the panel which adds up to two hundred and twenty (220) observations and forty-four (44) observations for each country analysis. However, after calibration; the observations will become 880 (eight hundred and eighty) observations for panel data and 176 (one hundred and seventy six) observations for the time series data respectively.

3.5 Theoretical Framework

This study is based on the Environmental Kuznets Curve (EKC) as describe by Grossman and Krueger (1991) and Kuznets (1955). The theory is selected because it is a pioneer theory that explicitly outlines the nexus between environmental degradation and Economic Growth, which has been tested in different economies (advanced and emerging) by different researchers across the globe. The EKC general model is quantitatively expressed as:

$$G_{it} = \partial + \gamma_1 K_{it} + \gamma_2 P_{it} + \mu_{,t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (3)$$

Where:

G_{it} = Economic growth indicator of certain country

∂ = Intercept

K = Vector of pollution index of certain country

P = other factors that are significant determinants of the dependent variable like trade openness among others.

$\gamma_1 and\ \gamma_2$ = unknown parameter to be estimated

μ = random perturb term

t = time effect

The assumption postulates different level of CO_2 emission per capita across countries at any given income level, while the income elasticity remain equal in all countries at a given income level. The fundamental initiative behind EKC hypothesis is that as a country's industrialization process increases, resources extraction increases as income increases, thereby raising the pollution levels. As income continues to rise over time, people become conscious of environmental quality and now become willing and able to afford cleaner energy, subsequently forcing pollutant emissions to decline after a certain period. This is how the inverted *U*-shape is realized (Mesagan, 2015).

The turning point is the stage beyond which economic growth increase result to environmental pollution reduction (scale effect reduction) due to the effect of international trade, education, technological effect and composition effect that promote clean environment demand and strengthened regulations. The turning point of the equation (3) can be obtained via first curvature vector. The inverted *U*-shaped relationship is anticipated where environment pollution index e.g., CO_2 emissions will have a positive coefficient on growth in the short run and a negative coefficient in the long run. That is $\gamma_1 > 0$ in the short run and $\gamma_1 < 0$ in the long run.

However, the hypothesis of the Environmental Daly Curve (EDC) hold a contrary opinion by asserting that higher economic growth will result to greater environmental damage. Thus, environment degradation and economic growth are directly related because of increased production. Contrary to Brundtland curve and EKC hypothesis, the Daly curve is devoid of any turning point irrespective of any given level of wealth because investment in green energy is insignificant to reverse the extent of damage that have been done (Brath, 2012). Thus, both hypotheses cannot be valid simultaneously. The presence of EKC implies the absence of EDC vice-visa.

3.6 Model Specification

This study adapted the Kuznets (1955) model in equation (3) modified to achieve the objectives of this study. First, the ECM model is specified to test the EKC hypothesis for each country analysis in the sample. Second, the VECM is specified to test the EKC hypothesis for the aggregate sample. Thus, the functional form of the model is given as:

$$EG = f(K, P) \ldots\ldots(4)$$

Where;

K = Carbon emissions (CO_2) and Fossil fuel (FOF) consumption

P = Electricity consumption (ELC), Trade openness (TOPN) and Human capital (HCP)

Thus, equation (4) is re-specified by expansion as:

$$EG_{i,t} = f(CO_2, FOF, ELC, TOPN, HCP) \ldots\ldots(5)$$

The long run estimated version with the assumption of homogenous mean and variance assumption is given as:

$$\Delta EG_{i,t} = \aleph_0 + \delta_1 CO_{2t} + \delta_2 FOF_t + \delta_3 ELC_t + \delta_4 TOPN_t + \delta_5 HCP_t + \mu t_{i,t} \ldots\ldots(6)$$

The short run ECM applied in this study is specified as;

$$\Delta EG_{i,t} = \aleph_0 + \delta_1 \sum_{t=1}^{L} \Delta EG_{i,t-1} + \delta_2 \sum_{t=1}^{L} \Delta CO_{2i,t-1} + \delta_3 \sum_{t=1}^{L} \Delta FOF_{i,t-1} + \delta_4 \sum_{t=1}^{L} \Delta ELC_{i,t-1} + \delta_5 \sum_{t=1}^{L} \Delta TOPN_{i,t-1} + \delta_6 \sum_{t=1}^{L} \Delta HCP_{i,t-1} + \varphi 1 ECM(-1) + \mu t_{i,t} \ldots (7)$$

Model 6 and 7 is estimated for each country in the sample respectively.

Where:

EG = Economic growth

CO_2 = Carbon emissions

FOF = Fossil fuel

ELC = Electricity consumption

TOPN = Trade openness

HCP = Human capital

$\aleph_0$ = Constant

δ_1, δ_2,δ_3, δ_4, δ_5 and δ_6 = Unknown coefficient for the short-term impacts to be calculated

$ECM(-1)$ = Error correction term which include information whether past values influence current values of the variables considered in the model.

$\varphi 1$ = Caters for long run impact.

μt = Stochastic term

Δ = Changes

t and *i* = respective variables for each country at time *t*

a priori expectation as derived from theoretical literature is expressed as;

$\aleph_0 > 0$, δ_1 *and* δ_2, < 0, δ_3, δ_4, $\delta_5 > 0$ in the long run .

$\aleph_0 > 0$, $\delta_1 > 0$, δ_2,δ_3, δ_4, $\delta_5 > 0$ in the short run

We reiterate here that the EKC model holds and valid if and only if δ_2 in model (7) is > 0 and δ_1 in model (6) is < 0, hence the inverted *U* shape is established for that specific country;

otherwise the EDC holds. Khan, Khan and Rehan (2020) and Mesagan (2015) used similar approach in their study in Pakistan and Nigeria respectively.

To test the validity of EKC hypothesis for the aggregate sample based on panel data, all variables must be integrated of order I(0) or I(1) or combination of both, certainly not order I(2) (Johansen, 1991). The Akaike Information Criterion (AIC) will be used to determine the optimal lag selection in the panel VECM model. The Johansen co-integration will be used to established long run relationship between the variables because the model is a system empirical equation. Stemming from model (5), the estimated systematic panel VECM is stated as:

$$EG_t = \alpha_{1t} + \sum_{j=i}^{n} \beta_{1j,t} EG_{t-1} + \sum_{j=i}^{n} \beta_{2j,t} CO_{2t-1} + \sum_{j=i}^{n} \beta_{3j,t} FOF_{t-1} + \sum_{j=i}^{n} \beta_{4j,t} ELC_{t-1} + \sum_{j=i}^{n} \beta_{5j,t} TOPN_{t-1} + \sum_{j=i}^{n} \beta_{6j,t} HCP_{t-1} + \delta_1 \gamma_{t-1} + \epsilon_{it} \quad \text{……………………… …}(8a)$$

$$CO_{2t} = \alpha_{1t} + \sum_{j=i}^{n} \beta_{1j,t} CO_{2t-1} + \sum_{j=i}^{n} \beta_{2j,t} EG_{t-1} + \sum_{j=i}^{n} \beta_{3j,t} FOF_{t-1} + \sum_{j=i}^{n} \beta_{4j,t} ELC_{t-1} + \sum_{j=i}^{n} \beta_{5j,t} TOPN_{t-1} + \sum_{j=i}^{n} \beta_{6j,t} HCP_{t-1} + \delta_1 \gamma_{t-1} + \epsilon_{it} \quad \text{……………………… …}(8b)$$

$$FOF_t = \alpha_{1t} + \sum_{j=i}^{n} \beta_{1j,t} FOF_{t-1} + \sum_{j=i}^{n} \beta_{2j,t} EG_{t-1} + \sum_{j=i}^{n} \beta_{3j,t} CO_{2t-1} + \sum_{j=i}^{n} \beta_{4j,t} ELC_{t-1} + \sum_{j=i}^{n} \beta_{5j,t} TOPN_{t-1} + \sum_{j=i}^{n} \beta_{6j,t} HCP_{t-1} + \delta_1 \gamma_{t-1} + \epsilon_{it} \quad \text{……………………… …}(8c)$$

$$ELC_t = \alpha_{1t} + \sum_{j=i}^{n} \beta_{1j,t} ELC_{t-1} + \sum_{j=i}^{n} \beta_{2j,t} EG_{t-1} + \sum_{j=i}^{n} \beta_{3j,t} CO_{2t-1} + \sum_{j=i}^{n} \beta_{4j,t} FOF_{t-1} + \sum_{j=i}^{n} \beta_{5j,t} TOPN_{t-1} + \sum_{j=i}^{n} \beta_{6j,t} HCP_{t-1} + \delta_1 \gamma_{t-1} + \epsilon_{it} \quad \text{……………………… …}(8d)$$

$$TOPN_t = \alpha_{1t} + \sum_{j=i}^{n} \beta_{1j,t} TOPN_{t-1} + \sum_{j=i}^{n} \beta_{2j,t} EG_{t-1} + \sum_{j=i}^{n} \beta_{3j,t} CO_{2t-1} + \sum_{j=i}^{n} \beta_{4j,t} ELC_{t-1} + \sum_{j=i}^{n} \beta_{5j,t} ELC_{t-1} + \sum_{j=i}^{n} \beta_{6j,t} HCP_{t-1} + \delta_1 \gamma_{t-1} + \epsilon_{it} \ldots\ldots\ldots\ldots \ldots\ldots\ldots\ldots \ldots(8e)$$

$$HCP_t = \alpha_{1t} + \sum_{j=i}^{n} \beta_{1j,t} HCP_{t-1} + \sum_{j=i}^{n} \beta_{2j,t} EG_{t-1} + \sum_{j=i}^{n} \beta_{3j,t} CO_{2t-1} + \sum_{j=i}^{n} \beta_{4j,t} ELC_{t-1} + \sum_{j=i}^{n} \beta_{5j,t} TOPN_{t-1} + \sum_{j=i}^{n} \beta_{6j,t} TOPN_{t-1} + \delta_1 \gamma_{t-1} + \epsilon_{it} \ldots\ldots\ldots\ldots \ldots\ldots\ldots\ldots \ldots(8f)$$

Where:

n = Maximum number of lag

α = Autonomous term

β_1, β_2, β_3, β_4, β_5, β_6, = Parameter of explanatory variables to be estimated.

γ_{t-1} = Error correction term

ϵ_{it} = Stochastic term

jt = Each country's variable *j* at time *t*

Other variables remain the same as defined in model (6) and (7)

The *a priori* expectation is derived from the theoretical literature is given as;

$\alpha_0 > 0$

β_1 , β_4, β_5 and β_6 > 0 both in the short and long run

β_2, $\beta_3 > 0$ in the short run and β_2 and $\beta_3 < 0$ in the long run.

The EKC model holds only if β_2 and β_3 in model (8a) is > 0 in the short run and β_2 and β_3 in model (8a) is < 0 in the long run. Hence, the inverted *U* shape is established for African countries; otherwise the EDC holds vice-visa.

3.7 Preliminary Test

Descriptive statistic, correlation analysis, unit root test, and co-integration analysis are the primary tests that were used in this study. The basic features of the samples and their corresponding measures is described, summarized and analysed with the descriptive statistics to form the basis of the quantitative analysis of the variables in this study. Without referring to cause and effect, the strength and direction of the linear association between the variables of interest was ascertained with the correlation analysis.

The panel unit root and time series unit root of Augmented Dickey Fuller (ADF) test was applied to determine the stationarity status of the variables. This is germane because the studies involved both cross country and country specific analysis which reveals more detailed information. The former take the panel unit root while the latter takes the time series unit root test. All variables are integrated of the same order. Thus, the panel co-integration based on Kao (1997) and Pedroni (1999) procedure and the Engle and Granger (E&G) two stage co-integration techniques (Engle & Granger, 1987) was adopted to determine the existence of long run association between the variables after short run shock respectively. These co-integration approaches selected are preferred because the models are panel Dynamic system equation and single equation of Autoregressive Distributed Lag (ARDL) model.

3.8 Method of Data Analysis

When all series result are integrated of the same order one and co-integrated, the study applied the Autoregressive Distributed Lag (ARDL) Error Correction Model (ECM) techniques to estimate the time series data for each sample country and panel VECM techniques is used to estimate the panel data for the whole sample to ascertain the short run dynamics and long run equilibrium causality association between the endogenous variables.

This is pertinent to test the existence and applicability of the EKC hypothesis in the entire sample and specific country sample respectively. Specific country analysis is important because the level of adoption and policy implementation of carbon footprint may differ from one country to another within Africa.

The ARDL ECM and the panel VECM are used because they have the potentials of combining short run dynamic and long run equilibrium properties to produce a reliable estimate in a unified system when the variables are co-integrated thus, enhancing flexibility. Also panel VECM is informed because it control for endogeneity problem by allowing interaction among variables in the system equation.

Simultaneously, the ARDL ECM and the panel VECM technique ensure data coherence, theoretical rigour and data consistency (Nwachukwu & Egwaikhide, 2007). To ensure the validity and authenticity of the result, post regression test of Breausch-Godfrey serial correlation, normality test, and heteroscedasticity test were carried out to avoid the presence of serial correlation problem that will undermine the predictive power of our model.

3.9 Operationalization of Variables

The model underlying this study contains one dependent variable (economic growth) and five explanatory variables (carbon footprint (CO_2), fossil fuel emissions, electricity consumption, TOPN, and human capital) explained in table 3.1.

Table 3.1: Description of Variables

S/N	Variables	Description	Operations/Proxy	Sign	Source
1.	Economic Growth (EG)	Increase in total value of tangible and intangible output produced in a country within a year.	EG is proxy by changes in GDP; $\Delta EG = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} \times \frac{100}{1}$		Selin (2020), Ejuvbekpokpo (2014), Kasman and Duman (2015).
2.	Carbon footprint (CO_2)	Greenhouse gas emission that is	Proxy by annual CO_2 emissions in kiloton. This could also be	+/-	Selin (2020), Randelovic

		consumption related. Usually emitted by international transportation and shipping during importation of goods and services produce elsewhere.	called consumption CO_2 emissions		and Zdravkovic (2019).
3.	Fossil Fuel (FOF)	Greenhouse gas emission that is related to production within a country.	Proxy by annual per capita emissions in tones. This could also be called production CO_2 emissions	+/-	Selin (2020), Balcilar et al (2019)
4.	Electricity Consumption (ELC)	The major renewable hydroelectric power consumed in final production of goods and services.	Proxy by annual electricity power consumption in kWh	+	Mesagan (2015), Magazzino (2016).
5.	Trade Openness (TOPN)	The ratio of total trade to GDP	$TOPN = \frac{Net\ Import + Net\ Export}{GDP}$	+	Selin (2020), Kasman and Duman (2015)
6.	Human Capital (HCP)	The level of knowledgeable workforce in a country.	Proxy by total school enrolment.	+	Alege, et al (2016), Elom et al (2024).

Note: All variables were sourced annually and calibrated to quarterly data using E-views 10.0. See Appendix II

Source: Researcher's Compilation (2024).

CHAPTER FOUR

DATA PRESENTATION AND ANALYSES

4.1 Introduction

This section focused on the application of both statistical and econometric methods to present, analyse and interpret the collected data stream for this study. The formulated hypotheses were tested in this regard to form the basis for conclusion and recommendations at the end of this study.

4.2 Data Analyses for Specific Countries

The data stream collected for each country that constituted the sample is presented and analysed with the result output attached as appendices.

4.2.1 Nigerian Data Analysis

Tables 4.1: Summary Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob
CO_2	0.696098	0.66875	0.96125	0.437813	0.107881	0.1851	2.599231	2.033568	0.36176
EG	3.119268	3.873125	15.96281	-14.55687	5.496269	-0.7546	4.555483	32.09868	0.1000
ELC	106.5129	97.52532	157.9128	48.53	29.27263	0.1520	1.736974	11.53244	0.30313
FOF	19.53585	19.16625	22.90063	15.67781	1.544433	0.2401	2.784109	1.894068	0.38789
HCP	92.88269	91.3511	114.3441	77.82875	8.487018	0.7767	3.054489	16.51064	0.10026
TOPN	32.57098	33.49266	65.65969	7.794688	12.50139	-0.2512	2.460052	3.715063	0.15606

Source: Researcher's Estimation Using E-views (2024)

In table 4.1, the ratio of mean to median for majority of the variables is not almost one. This is evidence in the variables STD. Dev for values that are very high (except for CO_2) showing high level of dispersion from their mean. This means the variables considered were not consistent over time as shown by the significant variation between min and max values. The Jarque-Bera (J-Bera) that put Kurtosis and Skewness values into consideration in its estimate shows that all variables are normally distributed because their probability values are not significant at 5% confidence level. Thus, a parametric estimation technique becomes suitable and imperative.

Table 4.2: Correlation Matrix (Nigeria)

Correlation t-Statistic Probability	CO2	EG	ELC	FOF	HCP	TOPN
CO2	1.000000 ----- -----					
EG	-0.338920* -4.585117 0.0000	1.000000 ----- -----				
ELC	-0.613960 -9.900007 0.0000	0.314385* 4.215195 0.0000	1.000000 ----- -----			
FOF	0.450164 6.416573 0.0000	-0.220258* -2.874001 0.0046	-0.255358 -3.361624 0.0010	1.000000 ----- -----		
HCP	0.399816 5.551883 0.0000	-0.320687* -4.309267 0.0000	-0.318385 -4.274841 0.0000	0.455251 6.507905 0.0000	1.000000 ----- -----	
TOPN	-0.308882 -4.133553 0.0001	0.509138* 7.529205 0.0000	0.175816 2.273183 0.0243	-0.217922 -2.842004 0.0051	-0.395273 -5.477028 0.0000	1.000000 ----- -----

**=1% Significant Level*
Source: Researcher's Estimation Using E-views (2024)

Table 4.2 shows the relationship strength and direction among the variables considered. The variables have significant mixed (positive and negative) association with Economic Growth. First CO_2, FOF, and HCP have significant weak negative relation with Economic Growth. This means that increase in these variables resulted to decrease in Economic Growth during the studied period. Second, ELC and TOPN have a significant positive nexus with Economic Growth. This indicates that increase in these variables spur Economic Growth in the studied period considered.

Table 4.3 Stationarity Test (Nigeria)

	Augumented Dicky-Fuller (ADF) Test		
Variables	**ADF Stat**	**Order**	**Remark**
CO2	-4.098386*	1(1)	Stationary
EG	-4.754929*	“”	“”
ELC	-4.638815*	“”	“”
FOF	-3.707199**	“”	“”
HCP	-3.639761**	“”	“”
TOPN	-4.760582*	“”	“”
Critical Values			

1%	-4.020396	1(1)	1st Diff
5%	-3.440059	1(1)	“”
10%	-3.144465	1(1)	“”
, **, and * indicates stationary at 1%, 5% and 10% levels respectively*			

Source: Researcher's Estimation Using E-views (2024)

As a necessary condition for ECM estimation, all variables must be integrated of order one I(1). Table 4.3 shows that at first difference, all variables are integrated of order I(1). Since the variables corresponding ADF statistics values is greater than the critical values at 5% significance level when compared. Thus, the variables are stationary and fit to be used in the ECM model without producing spurious regression output.

Table 4.4: Co-integration Test (Nigeria)

Engle and Granger 2 Stage Co-integration			
Variable	**ADF Stat**	**Prob**	**Remark**
Residual (ECM)	-4.470821*	0.000	Stationary
Critical value = -2.580065, & * = 1% Significance Level			

Source: Researcher's Estimation Using E-views (2024)

In table 4.4, the ADF stat (-4.470821) is > -2.580065 critical value. This shows that the variables are co-integrated (long run relationship exist). That is, any variable that deviate due to short run shock will adjust to long run equilibrium.

Table 4.5: Long Run General Least Square (GLS) Regression Result (Nigeria)

Variables	Coefficient	T-stat	Prob
Dependent Variable = EG			
C	-34.18682*	-3.019583	0.0030
CO_2	-24.54064*	6.202717	0.0000
ELC	0.104947*	3.410047	0.0008
FOF	-1.077092*	-2.990948	0.0032
HCP	0.337846*	3.872308	0.0002
TOPN	-0.032580	-0.604696	0.5463
AR(1)	1.541616	24.96624	0.0000
AR(2)	-0.590807	-9.698327	0.0000
R^2	0.933688		
Adj R^2	0.930674		
F-stat	309.7668*		
F-stat Prob	0.000000		
D.W Stat	2.234465		
* = 1% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The serial correlation in the Ordinary Least Square (OLS) result was corrected with the Cochrain-Orcutt AR(2). Convergence is achieved after 12 iterations with 162 observations included. The GLS result in table 4.5 shows that 93% of total systematic changes in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination R2 value of 0.93 after adjusted for degree of freedom in the long run. There is a significant association between all explanatory variables and Economic Growth as indicated by the F-statistic value of 309.77 in the long run and it is significant at 5% confidence level. Only TOPN failed to pass its significant test at 5% and it will not be relevant for long run policy formulation. The explanatory variables have different degree of effect on Economic Growth in Nigeria. CO_2, FOF and TOPN have negative influence on Economic Growth while other variables have positive effect on Economic Growth in Nigeria.

Table 4.6: Parsimonious ECM Short Run Regression Result(Nigeria)

Variables	Coefficient	T-stat	Prob
Dependent Variable = ΔEG			
C	3.487374	1.143550	0.2547
EG(-1)	0.845203*	23.43904	0.0000
CO_2	24.21812*	7.291206	0.0000
CO_2(-1)	-23.64957*	-7.115182	0.0000
ELC	0.095993*	3.632577	0.0004
ELC(-1)	-0.099982*	-3.814670	0.0002
FOF	-0.724023**	-2.426987	0.0165
FOF(-1)	0.467677	1.492720	0.1377
HCP	0.332186*	4.555453	0.0000
HCP(-1)	-0.310190*	-4.372008	0.0000
TOPN	-0.071092	-1.573853	0.1177
TOPN(-1)	0.076115***	1.704025	0.0905
ECM(-1)	-0.634445*	7.603587	0.0000
R^2	0.931187		
Adj R^2	0.924975		
F-stat	149.8943*		
F-stat Prob	0.000000		
D.W Stat	2.173391		
Breusch-Godfrey Serial Correlation LM Test:			

F-stats	Prob		
4.144862	0.7178		
*, ** & *** = 1%, 5% and 10% Significant Level Respectively			

Source: Researcher's Estimation Using E-views (2024)

The ECM result in table 4.6 shows that the Error Correction Term (ECT) of -0.63 approximately is correctly signed and significant at 5% confidence level. This means that previous year disequilibrium is corrected in the long run at an approximate speed of 63%. The average value of Economic Growth holding other factors constant is 3.487374 in the short run as indicated by the intercept coefficient. After adjusted for degree of freedom, 93% of total systematic changes in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination R^2 value of 0.93 in the short run. Significant nexus exist between independent variables taken together and Economic Growth as indicated by the significant F-stat value of 149.89 in the short run.

Individually, all explanatory variables (except for TOPN) passed their significant test as indicated by their corresponding probability that is < 0.05. This means that CO_2 and other variables significantly affect Economic Growth in the short run. The lag values considered are also significant (except for FOF). Specifically, the lag values of CO_2-1, ELC-1, HCP(-1) have significant negative effect on current year CO_2, ELC, and HCP respectively. Other lag variables like FOF(-1) and TOPN(-1) have positive effect on the current year FOF and TOPN.

The Durbin-Watson (D.W) statistics value of 2.17 and 2.23 in table 4.5 and 4.6 respectively which can be approximated to 2.0 shows there may be absence of serial correlation in the model. This is further confirmed by the F-statistics value of 4.144862 that is not significant at 5% level in the Breusch-Godfrey serial correlation test. This shows that the model can be used for policy making without re-specification.

4.2.2 Data Analysis for Angola

Tables 4.7: Summary Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob
CO_2	0.826949	0.7925	1.291875	0.43	0.28172	0.192351	1.643356	13.58795	0.201121
EG	3.512868	3.468907	16.815	-25.7869	7.071575	-1.112658	6.888233	137.1477	0.30000
ELC	130.8697	75.13469	314.7316	47.85844	95.59154	0.910896	2.18863	27.17785	0.100001
FOF	32.32117	27.25016	48.45062	15.91	11.21771	0.331107	1.492454	18.5267	0.300095
HCP	89.73898	79.16	152.1581	64.05094	22.59491	0.40434	1.796738	14.36233	0.100761
TOPN	64.96651	52.71531	168.9259	5.74	41.65564	0.387656	2.115161	8.304296	0.157310

Source: Researcher's Estimation Using E-views (2024)

The ratio of mean to median for majority of the variables is not almost one in table 4.7. This is shown in the variables STD Dev values that are very high (except for CO_2 and Economic Growth) showing high level of dispersion from their mean. This means the variables considered were not consistent with a uniform trend over time. There is a meaningful variation between min and max values. The Jarque-Bera (J-Bera) that considered Kurtosis and Skewness values in its estimate shows that all the variables are normally distributed because their probability values are not significant at 5% confidence level. Thus, parametric preliminary test of stationarity is needed to ensure constant mean and variance in the data set.

Table 4.8: Correlation Matrix (Angola)

Correlation t-Statistic Probability	CO_2	EG	ELC	FOF	HCP	TOPN
CO_2	1.000000 ----- -----					
EG	0.269623* 3.336487 0.0011	1.000000 ----- -----				
ELC	0.765094 14.15885 0.0000	-0.103471 -1.239650 0.2171	1.000000 ----- -----			
FOF	0.862655 20.32394 0.0000	0.044697 0.533162 0.5948	0.940390 32.94949 0.0000	1.000000 ----- -----		
HCP	0.726775 12.60856 0.0000	-0.086041 -1.029115 0.3052	0.922368 28.45187 0.0000	0.915705 27.15403 0.0000	1.000000 ----- -----	
TOPN	0.640488 9.938296 0.0000	0.355671* 4.534838 0.0000	0.263472 3.254629 0.0014	0.479486 6.511013 0.0000	0.227455 2.783393 0.0061	1.000000 ----- -----

**=1% Significant Level*
Source: Researcher's Estimation Using E-views (2024)

Table 4.8 indicates the strength and direction of association among the variables considered. Only CO_2 and TOPN variables have significant direct association with Economic Growth. This means that increase in these variables increases Economic Growth during the studied period. While FOF, HCP, and ELC have a non-significant inverse association with Economic Growth. This suggests that increase in these variables decreases Economic Growth during the studied period.

Table 4.9: Stationarity Test (Angola)

	Augumented Dicky-Fuller (ADF) Test		
Variables	**ADF Stat**	**Order**	**Remark**
CO_2	-4.586663*	1(1)	Stationary
EG	-5.605010*	""	""
ELC	-4.613216*	""	""
FOF	-4.825934*	""	""
HCP	-4.494150*	""	""
TOPN	-4.734410*	""	""
Critical Values			
1%	-4.017185	1(1)	
5%	-3.438515	1(1)	
10%	-3.143558	1(1)	
, **, and * indicates stationary at 1%, 5% and 10% levels respectively*			

Source: Researcher's Estimation Using E-views (2024)

As a pre-requisite estimation condition for ECM, all variables must be integrated of order one I(1). Table 4.9 shows that at first difference, all variables are integrated of order I(1). Since the variables corresponding ADF statistic values is greater than the critical values at 5% significance level. Thus, the variables are stationary and fit to be used in the ECM model without producing spurious regression output.

Table 4.10: Co-integration Test (Angola)

Engle and Granger 2 Stage Co-integration			
Variable	**ADF Stat**	**Prob**	**Remark**
Residual (ECM)	-5.838261	0.000	Stationary
Critical value = -4.025924, & * = 1% Significance Level			

Source: Researcher's Estimation Using E-views (2024)

In table 4.10, the ADF stat (-5.838261) absolute value is > -4.025924 critical value. This means that the variables are co-integrated (long run relationship exist). That is, any variable that deviate due to short run shock will adjust to long run equilibrium.

Table 4.11: Long Run Regression Result (Angola)

Variables	Coefficient	T-stat	Prob
Dependent Variable = EG			
C	-12.71507	-1.566469	0.1196
CO_2	-23.89669*	-4.032058	0.0001
ELC	-0.104770*	-4.162558	0.0001
FOF	1.723843*	8.211871	0.0000
HCP	-0.106451	-1.434710	0.1537
TOPN	0.022655	0.912577	0.3631
AR(1)	1.628310	25.45390	0.0000
AR(2)	-0.690524	-10.89299	0.0000
R^2	0.951542		
Adj R^2	0.949011		
F-stat	375.8969*		
F-stat Prob	0.000000		
D.W Stat	2.292923		
* = 1% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The autocorrelation correlation in the OLS result was corrected with the Cochrain-Orcutt AR (2). Convergence is achieved after 9 iterations with 142 observations included. The GLS result in table 4.11 shows that 95% of total systematic variations in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination R^2 value of 0.95 approximately after adjusting for degree of freedom in the long run. This shows that the model has a tight fit of the regression in the long run line as only 5% dynamic changes in Economic Growth is not explained in the model but captured by the random error term. There is a significant association between all explanatory variables and Economic Growth as indicated by the F-statistic value of 375.8969 in the long run and it is significant at 5% confidence level. Only HCP and TOPN did not pass their significant test at 5% level and this implies that both variables are not relevant for long run policy formulation. The explanatory variables have different degree of effect on Economic Growth in Nigeria. CO_2, FOF, and HCP have significant negative effect on Economic Growth in the long while other variables have non-significant positive effect on Economic Growth in Nigeria in the long run. There may be absence of autocorrelation in the model and the model is fit for long run policy recommendation without re-specification since the D.W statistics value of 2.29 can be approximated to 2.0.

Table 4.12: Parsimonious ECM Short Run Regression Result (Angola)

Variables	Coefficient	T-stat	Prob.
Dependent Variable = ΔEG			
C	-4.049310	-0.647632	0.5184
EG(-1)	0.770643*	3.022510	0.0030
CO_2	-23.41786*	-3.528941	0.0006
CO_2(-1)	23.88626*	3.143915	0.0021
ELC	-0.058933	-1.452680	0.1488
ELC(-1)	0.026790	0.535745	0.5931
FOF	1.824536*	6.492215	0.0000
FOF(-1)	-1.502409*	-2.904480	0.0043
HCP	-0.018452	-0.192286	0.8478
HCP(-1)	-0.004690	-0.048663	0.9613
TOPN	0.004722	0.171279	0.8643
TOPN(-1)	-0.009226	-0.329895	0.7420
ECM(-1)	-0.099115**	-1.456127	0.0478
AR(1)	0.788539	3.223763	0.0016
R^2	0.953554		
Adj R^2	0.948762		
F-stat	198.9854*		
F-stat Prob	0.000000		
D.W Stat	1.943086		
Breusch-Godfrey Serial Correlation LM Test:			
F-stats	**Prob**		
4.640635	0.2016		

* = 1% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The ECM result in table 4.12 shows that the ECT of -0.10 approximately is correctly signed and significant at 5% confidence level and this was achieved after 45 iterations with 140 observations included. This means that previous year disequilibrium is slowly corrected in the long run at an approximate speed of 10% in Angola. The average value of Economic Growth holding other factors constant is -4.049310 in the short run as indicated by the intercept coefficient. After adjusted for degree of freedom, 95% of total systematic changes in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination adjusted R^2 value of 0.94876 in the short run. Significant nexus exist between all independent variables taken together and Economic Growth as indicated by the significant F-stat value of 198.9854 in the short run.

On Individual test basis, only CO_2 and FOF variables pass their significant test as indicated by their corresponding probability that is < 0.05. This means that CO_2 and FOF variables significantly contributed to EG in the short run during the studied period. None of the lag values considered are significant except for EG(-1) and CO_2(-1) respectively. Specifically, the lag values of EG(-1) and CO_2-1, have significant positive effect on current year CO_2, EG respectively.

The Durbin-Watson (D.W) statistics value of 1.94 in table 4.12 can be approximated to 2.0 shows that there may be absence of serial correlation in the model. This is further confirmed by the F-statistics value of 4.640635 that is not significant at 0.05% level in the Breusch-Godfrey serial correlation test. This shows that the model can be used for policy making without re-specification.

4.2.3 Data Analysis for Algeria

Tables 4.13 Summary Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob
CO_2	2.946746	2.930313	4.03	1.88	0.478391	0.007478	1.821089	9.49871	0.208657
EG	2.717195	2.95	7.421875	-2.44688	2.203681	-0.21736	2.628767	2.233101	0.327407
ELC	786.9403	683.4418	1369.431	319.95	334.4872	0.570556	1.90194	17.13713	0.100190
FOF	99.82462	99.8315	99.98531	99.60187	0.102008	-0.319444	2.082978	8.535566	0.140130
HCP	103.1266	104.0188	119.6444	88.97	9.307656	0.105879	1.710827	11.6632	0.202933
TOPN	57.24523	57.39125	77.045	32.28	10.04841	-0.369866	2.844114	3.905275	0.141899

Source: Researcher's Estimation Using E-views (2024)

In table 4.13, the proportion of mean to median for most variables is almost one (except for EG). This is shown in the variables STD Dev values that are relatively low (except for ELC) showing low level of dispersion from their corresponding mean values. This means the variables considered were relatively consistent with a uniform trend over time. There is a meaningful variation between min and max values. The Jarque-Bera (J-Bera) that considered Kurtosis and Skewness values in its estimate shows that the variables are normally distributed since their probability values are not significant at 5% confidence level. Thus, further preliminary test of stationarity is carried out.

Table 4.14: Correlation Matrix (Algeria)

Correlation t-Statistic Probability	CO_2	EG	ELC	FOF	HCP	TOPN
CO_2	1.000000 ----- -----					
EG	-0.274562* -3.634275 0.0004	1.000000 ----- -----				
ELC	0.586776 9.223155 0.0000	0.053462 0.681434 0.4966	1.000000 ----- -----			
FOF	0.428742 6.040320 0.0000	-0.450278* -6.418612 0.0000	0.539773 8.161209 0.0000	1.000000 ----- -----		
HCP	0.389860 5.388479 0.0000	0.167666** 2.164689 0.0319	0.610391 28.00586 0.0000	0.359694 4.906555 0.0000	1.000000 ----- -----	

TOPN	-0.035815	0.402852*	0.431814	-0.162510	0.653538	1.000000
	-0.456138	5.602166	6.093485	-2.096285	10.98990	-----
	0.6489	0.0000	0.0000	0.0376	0.0000	-----

**=1% Significant Level*

Source: Researcher's Estimation Using E-views (2024)

Table 4.14 displayed the strength and direction of association among the variables considered. Only ELC, HCP, and TOPN variables have significant direct association with Economic Growth. However, the relationship between ELC and Economic Growth is not significant. This means that increase in these variables increases EG during the studied period. While CO_2 and FOF have a significant inverse relationship with Economic Growth this suggests that increase in these variables significantly decreases Economic Growth during the studied period.

Table 4.15: Stationarity Test (Algeria)

	Augumented Dicky-Fuller (ADF) Test		
Variables	**ADF Stat**	**Order**	**Remark**
CO_2	-5.334073*	1(1)	Stationary
EG	-5.772824*	“”	“”
ELC	-4.018051*	“”	“”
FOF	-5.753601*	“”	“”
HCP	-4.775708*	“”	“”
TOPN	-4.543306*	“”	“”
Critical Values			
1%	-4.017185	1(1)	
5%	-3.438515	1(1)	
10%	-3.143558	1(1)	
, **, and * indicates stationary at 1%, 5% and 10% levels respectively*			

Source: Researcher's Estimation Using E-views (2024)

Table 4.15 shows that at first difference, all variables are integrated of order I(1). Since the variables corresponding ADF stat values is greater than the critical values at 5% significance level. Thus, the variables are stationary and fit to be used in the ECM model without producing spurious regression output.

Table 4.16: Co-integration Test (Algeria)

Engle and Granger 2 Stage Co-integration			
Variable	**ADF Stat**	**Prob**	**Remark**
Residual (ECM)	-6.080797*	0.000	Stationary
Critical value = -4.016064, & * = 1% Significance Level			

Source: Researcher's Estimation Using E-views (2021)

In table 4.16, the ADF stat coefficient of -6.080797 is > -4.025924 critical value in its absolute terms. This means that the variables are co-integrated (long run relationship exist). That is, any variable that deviate due to short run shock will adjust to long run equilibrium because of the error correction term that is endemic in co-integrating variables.

Table 4.17: Long Run Regression Result (Algeria)

Variables	**Coefficient**	**T-stat**	**Prob.**
Dependent Variable = EG			
C	1532.810	6.731600	0.0000
CO_2	-2.179338*	-2.717637	0.0073
ELC	0.008868*	3.716152	0.0003
FOF	-15.18978*	-6.686638	0.0000
HCP	-0.158301***	-1.881515	0.0618
TOPN	0.034580	0.882123	0.3791
AR(1)	1.416902	21.40155	0.0000
AR(2)	-0.562888	-8.500342	0.0000
R^2	0.925031		
Adj R^2	0.921623		
F-stat	271.4535*		
F-stat Prob	0.000000		
D.W Stat	2.253254		
* , & *** = 1% and 10% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The autocorrelation correlation in the OLS result was corrected with the Cochrain-Orcutt AR (2). Convergence is achieved after 9 iterations with 162 observations included. The GLS result in table 4.17 shows that 92% of total systematic variations in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination R^2 value of 0.92 approximately after adjusting for degree of freedom in the long run. This shows that the model has a good fit of the regression in the long run line as only 8% dynamic changes in EG is not explained in the model but captured by the random error term. There is a significant association between all explanatory variables and Economic Growth as indicated by the F-statistic value of 271.4535 in the long run and it is significant at 0.05% confidence level. Only TOPN did not pass its significant test at 0.05% level and this implies that TOPN did not meaningfully contribute to EG in the long run and it is not relevant for long run policy formulation. The explanatory variables have different degree of effect on Economic Growth in Algeria. CO_2, FOF and HCP have significant negative effect on Economic Growth in the long while ELC have significant positive effect on Economic Growth in Algeria in the long run. There may be absence of autocorrelation in the model and the model is fit for long run policy recommendation without re-specification since the D.W statistics value of 2.25325 can be approximated to 2.0.

Table 4.18: Parsimonious ECM Short Run Regression Result (Algeria)

Variables	Coefficient	T-stat	Prob.
Dependent Variable = ΔEG			
C	1712.125	16.71975	0.0000
EG(-1)	-0.413174*	-6.852444	0.0000
CO_2	0.402227	0.599594	0.5497
CO_2(-1)	-2.805084*	-4.273645	0.0000
ELC	0.021786*	5.801940	0.0000
ELC(-1)	-0.014590*	-3.972828	0.0001
FOF	-10.08313*	-5.157488	0.0000
FOF(-1)	-6.936884*	-3.212473	0.0016
HCP	-0.035581	-0.253988	0.7999
HCP(-1)	-0.066927	-0.449397	0.6538
TOPN	0.019075	0.555545	0.5794
TOPN(-1)	0.026444	0.771156	0.4418
ECM(-1)	-0.249883*	20.39853	0.0000
R^2	0.929828		
Adj R^2	0.924176		
F-stat	164.5287*		
F-stat Prob	0.000000		
D.W Stat	1.902322		
Breusch-Godfrey Serial Correlation LM Test:			
F-stats	**Prob**		
5.569853	0.1547		

* = 1% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The ECM result in table 4.18 shows that the ECT of -0.25 approximately is correctly signed and significant at 0.05% confidence level. This means that previous year disequilibrium is corrected in the long run at an approximate speed of 25% in Algeria and this is relatively slow. The average value of Economic Growth holding other factors constant is 1712.125 in the short run as indicated by the intercept value. After adjusted for degree of freedom, 92% of total systematic changes in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination adjusted R^2 value of 0.92 approximately in the short run. Significant nexus exist between all independent variables taken together and Economic Growth as indicated by the significant F-stat value of 164.5287 in the short run.

On bases of Individual test, only ELC variable pass its significant test as shown by the corresponding probability value that is < 0.05. This means that ELC variable significantly contributed to EG in the short run during the studied period. Also, EG(-1), CO_2(-1) and ELC(-1) lag values are significant respectively. Specifically, the significant lag values also have positive effect on current year CO_2 and ELC respectively.

The Durbin-Watson (D.W) statistics value of 1.90 in table 4.18 can be approximated to 2.0 shows that there may be absence of serial correlation in the model. This is further confirmed by the F-statistics value of 5.569853 that is not significant at 0.05% level in the Breusch-Godfrey serial correlation test. This shows that the model can be used for policy making without re-specification.

4.2.4 Data Analysis for Libya

Tables 4.19: Summary Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob
CO_2	8.074133	8.146875	9.62	5.865313	0.723024	-0.692555	3.533256	15.05311	0.400539
EG	22.33	11.9975	136.2312	-77.3475	35.75201	0.335336	4.061473	8.145382	0.217031
ELC	2088.747	2042.979	3892.104	978.46	771.2882	0.561166	2.563346	9.910362	0.107047
FOF	98.98583	99.1161	99.32188	98.18	0.242836	-1.500618	4.580833	78.62744	0.300000
HCP	108.8271	110.1246	114.1	101.5469	3.094683	-0.645798	2.462446	10.11211	0.206371
TOPN	81.8632	87.86844	141.9553	33.98781	28.11277	0.080932	2.103453	4.288313	0.117167

Source: Researcher's Estimation Using E-views (2024)

In table 4.19, the ratio of mean to median for most variables is almost one (except for EG and ELC). This is shown in the variables STD Dev values that are relatively low (except for ELC, EG and TOPN) showing narrow level of dispersion from their corresponding mean values. This means the variables considered were relatively consistent with a uniform trend over time. There is a meaningful variation between min and max values. The Jarque-Bera (J-Bera) that considered Kurtosis and Skewness values in its estimate shows that majority of the variables are normally distributed since their probability values are not significant at 5% confidence level. Further parametric preliminary test becomes imperative.

Table 4.20: Correlation Matrix (Libya)

Correlation t-Statistic Probability	CO_2	EG	ELC	FOF	HCP	TOPN
CO_2	1.000000 ----- -----					
EG	-0.195777* -2.205103 0.0293	1.000000 ----- -----				
ELC	0.218018 2.467448 0.0150	-0.449176* -5.553019 0.0000	1.000000 ----- -----			
FOF	0.678006 10.18810 0.0000	-0.259406* -2.966793 0.0036	0.441441 5.433997 0.0000	1.000000 ----- -----		
HCP	-0.419323 -5.101762 0.0000	0.364944* 4.329554 0.0000	-0.040427 -0.446893 0.6557	-0.263267 -3.014213 0.0031	1.000000 ----- -----	

TOPN	0.631089*	-0.468259*	0.425149	0.291691	-0.679166	1.000000
	8.986103	-5.853484	5.188167	3.368311	-10.22042	-----
	0.0000	0.0000	0.0000	0.0010	0.0000	-----

**=1% Significant Level*
Source: Researcher's Estimation Using E-views (2024)

Table 4.20 displayed the strength and direction of association among the variables considered. Only HCP variable has significant direct association with Economic Growth. This revealed that increase in this variables increases EG during the studied period. While CO_2, ELC, and FOF have a significant inverse relationship with Economic Growth. This suggests that, increase in these variables significantly decreases Economic Growth during the studied period in Libya.

Table 4.21: Stationarity Test (Libya)

	Augumented Dicky-Fuller (ADF) Test		
Variables	**ADF Stat**	**Order**	**Remark**
CO₂	-5.450152*	1(1)	Stationary
EG	-5.742481*	""	""
ELC	-4.518764*	""	""
FOF	-5.938280*	""	""
HCP	-5.154628*	""	""
TOPN	-4.106150*	""	""
Critical Values			
1%	-4.017185	1(1)	
5%	-3.438515	1(1)	
10%	-3.143558	1(1)	
, **, and * indicates stationary at 1%, 5% and 10% levels respectively*			

Source: Researcher's Estimation Using E-views (2024)

Table 4.21 shows that at first difference, all variables are integrated of order I(1). Since the variables corresponding ADF statistic values is greater than the critical values at 5% significance level. Thus, the variables are stationary of same order and fit to be used in the ECM model without producing spurious regression output.

Table 4.22: Co-integration Test (Libya)

Engle and Granger 2 Stage Co-integration			
Variable	**ADF Stat**	**Prob**	**Remark**
Residual (ECM)	-6.533545	0.000	Stationary

Critical value = -4.035648, & * = 1% Significance Level			

Source: Researcher's Estimation Using E-views (2024)

In table 4.22, the ADF stat coefficient of -6.533545 is > -4.035648 critical absolute value. This means that the variables are co-integrated (long run relationship exist). That is, any variable that deviate due to short run shock will adjust to long run equilibrium due to the error correction term that is endemic in co-integrating variables.

Table 4.23: Long Run Regression Result (Libya)

Variables	Coefficient	T-stat	Prob.
Dependent Variable = EG			
C	3674.582	0.470471	0.6389
CO_2	55.03419*	6.533582	0.0000
ELC	-0.031610***	-1.841494	0.0681
FOF	-36.04092	-0.452033	0.6521
HCP	-3.137361**	-2.156597	0.0331
TOPN	-1.281050*	-3.932005	0.0001
AR(1)	1.565864	21.35659	0.0000
AR(2)	-0.636141	-8.649802	0.0000
R^2	0.919615		
Adj R^2	0.914680		
F-stat	186.3118*		
F-stat Prob	0.000000		
D.W Stat	2.239901		
* , **& *** = 1%, 5% and 10% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The autocorrelation correlation in the OLS result was corrected with the Cochrain-Orcutt AR (2). Convergence is achieved after 17 iterations with 122 observations included. The GLS result in table 4.23 shows that 92% of total systematic variations in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination R^2 value of 0.92 approximately after adjusting for degree of freedom in the long run. This shows that the model has a good fit of the regression in the long run line as only 8% dynamic changes in Economic Growth is not explained by the model but captured by the random error term. There is a significant association between all explanatory variables and Economic Growth as indicated by the F-statistic value of 186.3118 in the long run and it is significant at 0.05% confidence level. Only FOF did not pass its significant test at 0.05% level and this implies that FOF did not meaningfully contribute to Economic Growth in the long run and it is not relevant for long run policy formulation. The explanatory variables have different degree of effect on Economic Growth in Libya. ELC, FOF, HCP, and TOPN have significant negative effect on Economic Growth in the longrun. However, the nexus between FOF and Economic Growth is not significant while only CO_2 has significant positive effect on Economic Growth in Libya in the long run. There may be absence of autocorrelation in the model and the model is fit for long run policy recommendation without re-specification since the D.W statistics value of 2.239901 can be approximated to 2.0.

Table 4.24: Parsimonious ECM Short Run Regression Result (Libya)

Variables	**Coefficient**	**T-stat**	**Prob.**
Dependent Variable = ΔEG			
C	-1889.409	-1.92E-05	1.0000
EG(-1)	2.604498	0.000170	0.9999
CO_2	46.60216*	5.269043	0.0000
CO_2(-1)	-58.31389	-0.000287	0.9998
ELC	-0.046670**	-2.280992	0.0245
ELC(-1)	0.079871	0.000347	0.9997
FOF	22.77243	0.262801	0.7932
FOF(-1)	0.595182	5.78E-07	1.0000
HCP	-3.701379*	-2.552020	0.0121
HCP(-1)	-0.744929	-2.27E-05	1.0000
TOPN	-1.184347*	-3.649266	0.0004
TOPN(-1)	1.622866	0.000234	0.9998
ECM(-1)	-0.862927*	4.616097	0.0000
AR(1)	0.582800	-0.000122	0.9999
R^2	0.931275		
Adj R^2	0.923002		
F-stat	112.5748*		
F-stat Prob	0.000000		
D.W Stat	2.029946		
Breusch-Godfrey Serial Correlation LM Test:			
F-stats	**Prob**		
4.569853	0.1747		
*,& ** = 1% & 5% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The ECM result in table 4.24 shows that the ECT of -0.86 approximately is correctly signed and significant at 0.05% confidence level. This means that previous year disequilibrium is corrected in the long run at an approximate speed of 86% in Libya and this is very fast. The average value of Economic Growth holding other factors constant is 2.604498 in the short run as indicated by the intercept value. After adjusted for degree of freedom, 92% of total systematic changes in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination adjusted R^2 value of 0.92 approximately in the short run. Significant nexus exist between all independent variables taken together and Economic Growth as indicated by the significant F-stat value of 112.5748 in the short run.

On bases of Individual test, only FOF variable fail to pass its significant test as shown by the corresponding probability value that is > 0.05. This means that FOF variable didn't significantly contribute to Economic Growth in the short run during the studied period. Also, none of the lag values considered has significant influence on Economic Growth respectively.

The Durbin-Watson (D.W) statistics value of 2.029946 in table 4.24 can be approximated to 2.0 shows that there may be absence of serial correlation in the model. This is further confirmed by the F-statistics value of 4.569853 that is not significant at 0.05% level in the Breusch-Godfrey serial correlation test. This implies that the model can be used for policy making without re-specification. However, this result is achieved with AR(1) after 81 iterations with 122 observations included.

4.2.5 Data Analysis for Egypt

Tables 4.25: Summary Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob
CO_2	1.846902	1.700626	2.508125	0.99	0.475113	0.132361	1.50003	15.85324	0.400361
EG	4.970577	4.797032	12.15	0.80875	2.028911	0.764511	4.120107	24.54906	0.100005
ELC	1070.264	976.4378	1702.897	369.36	460.6271	0.159763	1.484036	16.40166	0.300274
FOF	95.00438	94.25407	98.60031	88.51	2.263317	-0.309553	2.741341	3.076349	0.214773
HCP	92.9261	94.84641	106.2919	69.19	10.41779	-0.668454	2.645923	12.11371	0.102342
TOPN	50.0072	48.37813	75.83	28.93125	10.9982	0.471585	2.554793	7.433148	0.204317

Source: Researcher's Estimation Using E-views (2024)

In the same vain, table 4.25 unveil that the ratio of mean to median for most variables is almost one (except for ELC and TOPN). This is shown in the variables STD Dev values that are relatively low (except for ELC, HCP, and TOPN) showing narrow level of dispersion from their corresponding mean values. This means that majority of the variables considered were relatively stable with a uniform trend over time. There is a meaningful variation between min and max values. The Jarque-Bera (J-Bera) that considered Kurtosis and Skewness values in its estimate shows that majority of the variables are normally distributed since their probability values are not significant at 5% confidence level.

Table 4.26: Correlation Matrix

Correlation t-Statistic Probability	CO_2	EG	ELC	FOF	HCP	TOPN
CO_2	1.000000 ----- -----					
EG	-0.400884* -5.359300 0.0000	1.000000 ----- -----				
ELC	0.988565 80.29182 0.0000	-0.420741* -5.680241 0.0000	1.000000 ----- -----			
FOF	0.942583 34.56659 0.0000	-0.523161* -7.518335 0.0000	0.936735 32.77515 0.0000	1.000000 ----- -----		
HCP	0.890212 23.93348 0.0000	-0.556338* -8.199865 0.0000	0.898714 25.09933 0.0000	0.928661 30.66275 0.0000	1.000000 ----- -----	

TOPN	-0.331469	0.457568*	-0.367867	-0.452694	-0.503560	1.000000
	-4.302904	6.302521	-4.845182	-6.217959	-7.138439	-----
	0.0000	0.0000	0.0000	0.0000	0.0000	-----

**=1% Significant Level*

Source: Researcher's Estimation Using E-views (2024)

Table 4.26 shows the strength and direction of relationship among the variables considered. Only TOPN variable has significant direct association with Economic Growth. This revealed that increase in TOPN increases EG during the studied period. While CO_2 ELC, FOF, and HCP have a significant inverse relationship with Economic Growth; this suggests that increase in these variables significantly decreases Economic Growth during the studied period in Egypt.

Table 4.27: Stationarity Test (Egypt)

	Augumented Dicky-Fuller (ADF) Test		
Variables	**ADF Stat**	**Order**	**Remark**
CO_2	-4.657980*	1(1)	Stationary
EG	-6.131194*	“”	“”
ELC	-6.512875*	“”	“”
FOF	-5.124387*	“”	“”
HCP	-6.052743*	“”	“”
TOPN	-4.441028*	“”	“”
Critical Values			
1%	-4.017185	1(1)	
5%	-3.438515	1(1)	
10%	-3.143558	1(1)	
, **, and * indicates stationary at 1%, 5% and 10% levels respectively*			

Source: Researcher's Estimation Using E-views (2024)

Table 4.27 shows that at first difference, all variables are integrated of order I(1). Since the variables corresponding ADF statistic values is greater than the critical values at 5% significance level. Thus, the variables are stationary of same order and fit to be used in the ECM model without producing spurious regression result.

Table 4.28: Co-integration Test (Egypt)

Engle and Granger 2 Stage Co-integration			
Variable	**ADF Stat**	**Prob**	**Remark**
Residual (ECM)	-4.971514*	0.000	Stationary
Critical value = -4.023042, & * = 1% Significance Level			

Source: Researcher's Estimation Using E-views (2024)

In table 4.28, the ADF stat coefficient of -4.971514 is > -4.023042 critical absolute value. This means that the variables are co-integrated (long run relationship exist). That is, any variable that deviate due to short run shock will adjust and converge to long run equilibrium due to the error correction term that is inherent among co-integrating variables.

Table 4.29: Long Run Regression Result (Egypt)

Variables	Coefficient	T-stat	Prob.
Dependent Variable = EG			
C	18.58016	0.630342	0.5295
CO_2	-12.46494*	4.813413	0.0000
ELC	-0.012733*	-3.684662	0.0003
FOF	-0.192910	-0.607824	0.5443
HCP	-0.030114	-0.582262	0.5614
TOPN	-0.040484	-1.182409	0.2391
AR(1)	1.339742	17.85599	0.0000
AR(2)	-0.462427	-6.440475	0.0000
R^2	0.893693		
Adj R^2	0.888222		
F-stat	163.3309*		
F-stat Prob	0.000000		
D.W Stat	2.153957		
* = 1% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

The autocorrelation correlation in the OLS result was corrected with the Cochrain-Orcutt AR (2). Convergence is achieved after 15 iterations with 144 observations included. The GLS result in table 4.29 reveal that 89% of total systematic variations in Economic Growth is explained by all the explanatory variables taken together as indicated by the coefficient of determination R^2 value of 0.89 approximately after adjusting for degree of freedom in the long run. This shows that the model has a good fit of the regression in the long run line as only 11% dynamic changes in Economic Growth is not explained by the model but captured by the random error term. There is a significant association between all explanatory variables and Economic Growth as indicated by the F-statistic value of 163.3309 in the long run and it is significant at 0.05% confidence level. Only CO_2 and ELC pass their significant test at 0.05% level and this implies that both variables meaningfully contributed to Economic Growth in the long run and they are relevant for long run policy formulation. The explanatory variables have different degree of effect on Economic Growth in Egypt. ELC, FOF, HCP, and TOPN have non-significant negative effect on Economic Growth in the long (except for ELC). Only CO_2 has significant positive effect on Economic Growth in Egypt in the long run. There may be absence of autocorrelation in the model and the model is fit for long run policy recommendation without re-specification since the D.W statistics value of 2.153957 can be approximated to 2.0.

Table 4.30: Parsimonious ECM Short Run Regression Result (Egypt)

Variables	Coefficient	T-stat	Prob.
Dependent Variable = ΔEG			
C	94.43194	9.332315	0.0000
EG(-1)	-0.415224*	-5.969088	0.0000
CO_2	9.224235*	4.035385	0.0001
CO_2(-1)	-3.274170	-1.457843	0.1472
ELC	-0.017574*	-2.732131	0.0071
ELC(-1)	0.016088*	2.487304	0.0141
FOF	-0.236615	-0.736160	0.4629
FOF(-1)	-0.678576**	-2.156507	0.0328
HCP	-0.009180	-0.191526	0.8484
HCP(-1)	-0.117299*	-2.493053	0.0139
TOPN	-0.049083***	-1.651869	0.1009
TOPN(-1)	0.087040*	2.899211	0.0044
ECM(-1)	-0.240526*	17.58997	0.0000
R^2	0.895742		
Adj R^2	0.886406		
F-stat	95.93973*		
F-stat Prob	0.000000		
D.W Stat	2.021952		
Breusch-Godfrey Serial Correlation LM Test:			

F-stats	Prob		
3.844271	0.2138		
*, ** & *** = 1% , 5% and 10% Significant Level			

Source: Researcher's Estimation Using E-views (2024)

In table 4.30 the ECM result shows that the ECT of -0.24 approximately is correctly signed and significant at 0.05% confidence level. This means that previous year disequilibrium is corrected in the long run at an approximate speed of 24% in Egypt and this speed is relatively slow. The average value of EG holding other factors constant is 94.43194 in the short run as indicated by the intercept value. After adjusted for degree of freedom, 87% of total systematic changes in Economic Growth are explained by all the explanatory variables taken together as indicated by the coefficient of determination adjusted R^2 value of 0.87 approximately in the short run. Significant nexus exist between all independent variables taken together and Economic Growth as indicated by the significant F-stat value of 95.93973 in the short run in Egypt.

On basis of Individual test, only FOF and HCP variables fail to pass their significant test as shown by their corresponding probability value that is > 0.05. This means that FOF and HCP variables didn't significantly contribute to Economic Growth in the short run during the studied period in Egypt. Also, only the lag variable of CO_2 considered have no significant influence on Economic Growth respectively.

The Durbin-Watson (D.W) statistics value of 2.021952 in table 4.30 can be approximated to 2.0 shows that there may be absence of serial correlation in the model. This is further confirmed by the F-statistics value of 3.844271 that is not significant at 0.05% level in the Breusch-Godfrey serial correlation test. This implies that the model can be used for policy making without re-specification.

4.2.6 Analysis of Pooled Data

Tables 4.31: Summary Statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	J-Bera	Prob
CO_2	2.878195	1.7	9.38	0.44	2.761071	1.204496	2.935337	198.4202	0.20
EG	6.560769	4.18	123.14	-62.08	16.15925	2.948379	20.51827	11104	0.50
ELC	836.6667	559.783	3792.77	49.26	846.2581	1.270588	4.246225	273.6973	0.10
FOF	836.6667	559.783	3792.77	49.26	846.2581	1.270588	4.246225	273.6973	0.30
HCP	96.98182	98.2	142.74	64.25	14.58404	-0.412152	2.801828	22.99997	0.10
TOPN	55.83847	51.195	152.55	6.38	27.93508	0.984271	4.087733	160.1803	0.20
Joint J-Bera = 2641408, DF = 12, Prob = 0.09									

Source: Researcher's Estimation Using E-views (2024)

Table 4.231 indicate that the mean to median ratio for most variables is not almost one (except for CO_2 and HCP). This is shown in the variables STD Dev values that are relatively high (except for CO_2) showing great level of dispersion from their corresponding mean values. This means that majority of the variables considered were not relatively stable with a uniform trend over time in Africa. There is a meaningful variation between min and max values. This means that the variables considered varies from across country due to individual country political-socio- economic peculiarity. The Jarque-Bera (J-Bera) that considered Kurtosis and Skewness values in its joint estimations shows that all the variables are normally distributed since their probability value of 0.09 is not significant at 5% confidence level. Thus, VECM is suitable for this analysis.

Table 4.32: Correlation Matrix

Correlation	CO_2	EG	ELC	FOF	HCP	TOPN
CO_2	1.000000					
EG	0.366221*	1.000000				
ELC	0.685849*	0.220897	1.000000			
FOF	0.634212*	0.168860	0.688991	1.000000		
HCP	0.525031*	0.152130	0.545419	0.472037	1.000000	
TOPN	0.475900*	0.078510	0.425107	0.335464	0.203922	1.000000
t-Statistic	CO_2	EG	ELC	FOF	HCP	TOPN
CO_2	-----					
EG	10.74938	-----				
ELC	52.14790	6.186180	-----			
FOF	22.40449	4.679280	25.96466	-----		
HCP	16.84932	4.204073	17.77339	14.62460	-----	

TOPN	14.77916	2.150979	12.82774	9.726128	5.689261	-----
Probability	CO_2	EG	ELC	FOF	HCP	TOPN
CO_2	-----					
EG	0.0000	-----				
ELC	0.0000	0.0000	-----			
FOF	0.0000	0.0000	0.0000	-----		
HCP	0.0000	0.0000	0.0000	0.0000	-----	
TOPN	0.0000	0.0318	0.0000	0.0000	0.0000	-----

** = 1% Significance Level*
Source: Researcher's Estimation Using E-views (2024)

Table 4.32 shows the strength and direction of relationship among the variables considered. Only All variable has significant direct association with Economic Growth. This revealed that increase in the entire variables spur Economic Growth during the studied period in Africa. There is no correlation coefficient among explanatory variables that is up to 0.80 in table 4.32 because that is the genesis of multi-colinearity (Gujirati, 2008). This buttress the absent of multi-colinearity in the model.

Table 4.33 Panel Group Statonarity Test

Method	**CO_2**	**EG**	**ELC**	**FOF**	**HCP**	**TOPN**	**RM**
Levin, Lin & Chu t*	-1.91909**	-9.31614*	-9.64129*	-9.48596*	-6.05300*	-4.47453*	S
Breitung t-stat	-3.00446*	-6.26084*	-15.6122*	-5.17132*	-14.9078*	-14.9937*	S
Im, Pesaran and Shin W-stat	-11.5879*	-15.2553*	-17.7236*	-12.0252*	-14.4174*	-13.6816*	S
ADF - Fisher Chi-square	134.816*	193.970*	235.597*	140.866*	177.525*	165.109*	S
PP - Fisher Chi-square	449.001*	422.864*	455.094*	451.869*	416.221*	399.353*	S
Order	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	
	All variables are integrated of Order one I(1), RM = Remark, S = Stationary						
	* = 1% level of Significance						

Source: Researcher's Estimation Using E-views (2024)

The group panel unit root test in Table 4.33 shows that all the variables are integrated of order I(1) irrespective of the method used. This implies that the variables are stationary with constant mean and variance which is a necessary criterion for panel VECM estimation.

Table 4.34: Optimal Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-19803.43	NA	1.29e+16	54.12413	54.16180	54.13866
1	-10820.08	17794.88*	311939.0*	29.67782*	29.94151*	29.77954*
2	-10813.67	12.60257	338207.3	29.75865*	30.24837	29.94757
* indicates lag order selected by the criterion						

LR: sequential modified LR test statistic test @ 5% level)
FPE: Final prediction error AIC: Akaike information criterion
SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Source: Researcher's Estimation Using E-views (2024)

The AIC is used to determine the optimum lag for the VECM estimation to avoid misspecification, adequate degree of freedom and serial correlation problem that may arise when optimal lag is not selected. This study selects two (2) as the optimal lag as indicated by the AIC in Table 4.34. The AIC is preferred because it coefficient of 29.75865 smaller when compared to that of SC and HQ. Thus, the AIC will guarantee more degree of freedom.

Table 4.35: Kao Co-integration Test

Variable	ADF Stat	Prob.	Remark
Kao Resid	-5.512465*	0.000	Co-integration exist
* = 1% significance Level			

Source: Researcher's Estimation Using E-views (2024)

The Kao residual based co-integration test in table 4.35 shows that the residual ADF stat value of 5.512465 is significant at 5% confidence level. This implies that long run relationship exist among variables of interest. Any variable that deviate in the short run will adjust to long run equilibrium. Thus, the VECM is estimated.

Table 4.36: Vector Error Correction Estimate

Long Run Result: Dependent Variable = EG						
	CO_2	**ELC**	**FOF**	**HCP**	**TOPN**	**C**
Co-integration	-3.670413*	0.003404	0.019324	-0.026919	0.103661**	-4.276711
StD Error	-1.26764	-0.00386	-0.05543	-0.12253	-0.05848	-
T-stat	[-2.89546]	[0.88092]	[0.34864]	[-0.21969]	[1.77256]	-
Short Run Result: Dependent Variable = ΔEG						
CointEq1	**D(EG)**	**D(CO_2)**	**D(ELC)**	**D(FOF)**	**D(HCP)**	**D(TOPN)**
ECT	-0.213658*	-0.000477	-0.429141*	0.001703	0.004192	-0.001686
StD Error	-0.02336	-0.00048	-0.14508	-0.00146	-0.0053	-0.01588
T-stat	[-9.14808]	[-0.98406]	[2.95803]	[1.16888]	[0.79123]	[-0.10617]
D(EG(-1))	0.094111*	0.000212	-0.186218	-0.000713	-0.001771	0.000779
	-0.04114	-0.00085	-0.25552	-0.00257	-0.00933	-0.02797
	[2.28780]	[0.24878]	[-0.72877]	[-0.27802]	[-0.18979]	[0.02784]

D(CO_2(-1))	1.344775	0.002666	-3.113922	-0.016114	-0.037488	0.005313
	-2.02804	-0.04209	-12.5975	-0.1265	-0.4601	-1.37891
	[0.66309]	[0.06334]	[-0.24719]	[-0.12739]	[-0.08148]	[0.00385]
D(ELC(-1))	0.00323	3.50E-06	-0.011041	-8.53E-05	-0.000186	-3.29E-05
	-0.00608	-0.00013	-0.03779	-0.00038	-0.00138	-0.00414
	[0.53090]	[0.02773]	[-0.29215]	[-0.22467]	[-0.13461]	[-0.00796]
D(FOF(-1))	0.313906	0.000249	-1.184748	-0.009746	-0.02106	-0.004636
	-0.61126	-0.01269	-3.79694	-0.03813	-0.13868	-0.41561
	[0.51354]	[0.01965]	[-0.31203]	[-0.25563]	[-0.15187]	[-0.01115]
D(HCP(-1))	0.011448	-2.31E-05	-0.082668	-0.000871	-0.001829	-0.000675
	-0.1672	-0.00347	-1.03861	-0.01043	-0.03793	-0.11369
	[0.06846]	[-0.00665]	[-0.07959]	[-0.08354]	[-0.04821]	[-0.00594]
D(TOPN(-1))	0.004257	1.29E-05	-0.004327	2.13E-05	3.00E-05	8.78E-05
	-0.05605	-0.00116	-0.34815	-0.0035	-0.01272	-0.03811
	[0.07595]	[0.01113]	[-0.01243]	[0.00609]	[0.00236]	[0.00230]
C	-0.10252	0.002894	4.03895	0.050918	0.10506	0.04838
	-0.33595	-0.00697	-2.08678	-0.02095	-0.07622	-0.22842
	[-0.30517]	[0.41507]	[1.93549]	[2.42998]	[1.37845]	[0.21181]
R^2	0.703614	0.001339	0.012009	0.001995	0.0009	0.000016
Adj. R^2	0.684948	-0.008316	0.002457	-0.007654	-0.00876	-0.009652
F-statistic	11.95543*	0.138693	1.257208	0.206753	0.093152	0.0017
*, ** = 1% and 5% Significance Level						

Source: Researcher's Estimation Using E-views (2024)

Table 4.36 indicate that three of the co-integrating variables Δ(EG), Δ(ELC), Δ(CO_2) and Δ(TOPN) are adjusting because they are correctly signed, as shown their corresponding negative coefficients in the short run CointEql. This means that the Error Correction Term (ECT) has the proper sign and speed of adjustment in the three variables to converge in the long run at 21% maximum speed. Only two (2) of the converging variable [D(EG)] and [D(ELC)] were statistically significant at 5% confidence level because their respective t-statistics ([-9.14808 and 2.95803) that is > 2.0 approximately. [D(FOF)] and [D(HCP)] are the non-adjusting variables and they are not statistically significant. This means that both variables have not significantly contributed to the long run equilibrium relationship. This means that all the converging variables are mutually causal as shown by VECM result. As the adjusting variables are the slave variables in ensuring long run causality relationship among variables in Africa.

Model 8a (first column in table 4.36) is the main model of concern. All the explanatory variables taken together explained about 69% of absolute systematic changes in Economic Growth after adjusted for degree of freedom as indicated by Adjusted R^2 value of 0.68 approximately. Only 32% of total systematic variation in bid-ask price were not explained by the model but captured by the stochastic error term, this buttress that the model has a good fit of the regression line. The F-statistic value of 11.95543 is significant at 5% confidence level. This show there exist a significant correlation between all the variables taken together.

4.3 Hypotheses Testing

The underlying hypotheses in this study were tested using the panel VECM t-statistics values in table 4.36. If the t-statistics value is < 2.0, then the null hypothesis is selected otherwise the alternate hypothesis is preferred and this serves as the decision rule.

Hypothesis One

Ho_1: CO_2 emission has no significant effect on Economic Growth in selected African countries. The t-statistic values for CO_2 are 1.344775 in the short run and -2.89546 in the long run which is > 2.0. Thus, the alternate hypothesis is chosen. This implies that CO_2 emission has significant effect on Economic Growth in selected African countries only in the long run. This assertion does not hold in the short run.

Hypothesis Two

Ho_2: Fossil fuel has no significant effect on Economic Growth in selected African countries.

Since the t-statistics value for FOF is 0.51354 in the short run and 0.34864 in the long and both are < 2.0. Then the null hypothesis is accepted. This implies that FOF has no significant effect on Economic Growth in selected African countries both in the short and long run.

Hypothesis Three

Ho_3: Electricity consumption has no significant effect on Economic Growth in selected African countries. The t-statistics value for ELC is 0.53090 in the short run and 0.88092 in the long and both are < 2.0. Then the null hypothesis is accepted. This implies that ELC has no significant effect on Economic Growth in selected African countries both in the short and long run.

Hypothesis Four

Ho_4: Human capital has no significant effect on Economic Growth in selected African countries. HCI t-statistics value is 0.06846 and -0.21969 in the short and long run respectively and both are < 2.0. This implies that human capital has no significant effect on Economic Growth in selected African countries in both short and long run period.

Hypothesis Five

Ho_5: Trade openness has no significant effect on Economic Growth in selected African countries. The t-statistic values for TOPN are 0.07595 in the short run and 1.77256 in the long run which is = 2.0 approximately. Thus, the alternate hypothesis is accepted. This implies that TOPN has significant effect on Economic Growth in selected African countries only in the long run. This assertion does not hold in the short run.

4.4 Discussion of Findings

The explanatory variables (CO_2 emission, FOF, ELC, HCP, and TOPN) considered have different magnitude and direction of effect on economic growth (EG) in Africa. Specifically in Nigeria (table 4.5 and 4.6), CO_2, ELC, FOF, and HCP conform to *a priori* expectation and they are significant both in the short and long run period (except for FOF that misbehaves in the short run). Only TOPN failed to behave in accordance with *a priori* expectation both in the short and long run and the variable is not significant. This implies that increase in CO_2, ELC and HCP significantly influence the Nigerian economic growth (EG) in the short run, Seetanah and Vinesh (2012), Al-Iriani (2006), Alege et al (2016) found similar result in their study. In the long run, increase in ELC and HCP still positively and significantly increases Economic Growth but CO_2 reduces Economic Growth significantly.

On the other hand, FOF and TOPN have a significant inverse effect on Economic Growth in Nigeria both in the short and long run period but FOF effect is significant only in the long run. Balcilar et al (2019) and Ahmed et al (2017) found similar result. However, the effect of TOPN was not significant during the period under review. This could be attributed to the high level of importation over export and exportation of primary product that has bedevilled the Nigeria economy over the years. This result also revealed that the carbon emission associated with the level of consumption might have been mitigated due to right policy mix by policy makers and investment in renewable energy technology towards achieving environmental sustainable goal is in the right direction. Also, unavoidable effect of changes in the global economy could also be a major factor. This is shown by the significant positive effect of renewable energy (ELC) on Economic Growth. However, this is also the case for the production carbon emission proxies by FOF by it negative and significant reduction effect on Economic Growth especially in the long run. The CO_2 short run positive effect and long run negative effect is a clear indication of inverted *U* shape thereby confirming the EKC hypothesis in the case of Nigeria consumption CO_2 of emission. This finding is in tandem with that of Omojolaibi (2010) and Safdari (2013) whom also confirm the validity of EKC hypothesis in their study.

Second, in Angola (table 4.11 and 4.12), the one year lag of EG (-1) considered directly and significantly impact current year Economic Growth and Mesagan (2015) in Nigeria report similar finding. CO_2, ELC, and HCP are not signed correctly. FOF and TOPN are correctly signed in the short run. Only the effect of CO_2 and FOF on Economic Growth was significant in Angola in the short run. FOF and TOPN have direct effect on Economic Growth in the short run; while CO_2, ELC and HCP are inversely related to Economic Growth in the short run. This is in line with the findings of Shabbir et al (2014) and Balcilar et al (2019) in their study. CO_2 and TOPN are correctly signed in the long run. FOF, HCP, and ELC are wrongly signed in the long run. CO_2 and ELC have significant negative effect on Economic Growth during the studied period and this conforms to the findings of Martins and Abdulsalam (2014), Alege et al (2016) in their study. This means that increase in these variables significantly decrease Economic Growth in Angola over the period considered. The behaviour of ELC could be attributed to poor renewable energy supply in Angola. Also, FOF has significant positive effect on Economic Growth in the long run. This means that production related carbon emission in Angola increases Economic Growth. However, the effect of TOPN was not significant in the long run. The findings shows that carbon emission that is related to production activities in Angola is still on the increase as the country strive to increase Economic Growth as evidence in the positive coefficient of FOF both in the short and long run. However, this is not the case in consumption related carbon emission as indicated by the negative coefficient of CO_2 that is significant both in the short and long run period; due to renewable energy technology. The two proxies for carbon emission (CO_2 and FOF) fail to conform to EKC hypotheses, thus, the EKC hypothesis is not valid in Angola. This finding is in line with that of Seetanah and Vinesh (2012), Cederborg and Snobohm (2016) in their study.

Third, in table 4.17 and 4.18 (Algeria), the lagged period of Economic Growth considered has a significant inverse effect on the current period EG. ELC, CO_2, and TOPN is correctly signed and only ELC is significant in the short run. Increase in these variables increased Economic Growth in Algeria during the studied period in the short run, this corroborate the findings of Ahmad et al (2019) and Al-Iriani (2006) in their study. Increase in FOF significantly reduced Economic Growth in Algeria in the short run. Although the effect of HCP on Economic Growth is negative but it is not significant in the short run. In the long run, only HCP is not correctly signed but it is significant in the long run. This could be attributed to low level of skilful human capital and government investment in education in the country. Also, increase in CO_2 and FOF significantly reduced Economic Growth in Algeria. Charfeddine and Mrabet 2017; Balcilar et al (2019) found similar result in their study. This implies that as Algeria strive to promote healthy green environmental sustainability as they promote Economic Growth by reducing carbon emission with the aid of renewable energy technology. This is evidence in the mixed coefficient value of CO_2 that is positive in the short and negative in the long run. Thereby, confirming the EKC hypothesis in Algeria. This conforms to the findings of Heidari et al (2015), Kasman and Duman (2015) in their study.

In Libya (table 4.23 and 4.24), The lag EG(-1) period considered has non-significant direct influence on current year Economic Growth and this is contrary to the findings of Mesagan (2015) in Nigeria. CO_2 and FOF are correctly signed in the short run with only CO_2 being significant. However, in the long run only FOF is correctly signed but it is not significant. This implies that increase in CO_2 and FOF significantly increased Economic Growth in Libya in the short run (except for FOF that is not significant); while in the long run CO_2 significantly increased Economic Growth and FOF insignificantly reduced EG. The behaviour of CO_2 in the long run could be attributed to high level of emissions from international transporting due to importation of goods and services Shuaibu and Oyinlola

(2013) reports the same finding in their study. This buttress that greenhouse sustainable strategies adopted in Libya have only been effective in mitigating carbon emissions emanating from production activities in a weak form and not consumption related activities. Thus, confirming the validity and applicability of an inverted *U*-Shape that is in line with EKC proposition in the Libya economy. However, the EKC hypothesis is not formidable in Libya because FOF coefficient is not significant in the long run. This finding follows that of Charfeddine and Mrabet (2017) in the literature. More so, high level of importation, low level of skilful human capital in Libya is further confirmed by the significant negative coefficients of ELC, HCP, and TOPN that are not correctly signed both in the short and long run period. This means that increase in ELC, HCP, and TOPN reduced Economic Growth in Libya during the studied period. This finding is in tandem with that of Alege et al (2016), Sarwar et al (2019), Ahmed et al (2017) in their study.

In Egypt (table 4.29 and 4.30), the previous year Economic Growth considered has significant negative effect on current year Economic Growth. Only CO_2 is correctly signed and significant in the short run. Other variables were wrongly signed with only ELC and TOPN being significant in the short run. This implies the consumption carbon emissions (CO_2) increased Economic Growth in Egypt due to economic expansion in a significant manner. Production CO_2 emissions (FOF) insignificantly reduced Economic Growth in Egypt during the period studied in the short run. Also, a percentage increase in ELC and TOPN will significantly reduce EG by the corresponding variables coefficients in table 4.30 in the short run. This is synonymous with the findings of Alege et al (2016) and Ahmed et al (2017) in their study.

In the long run, CO_2 significantly reduced Economic Growth to confirm the inverted *U*-Shape EKC hypothesis in Egypt. ELC also significantly reduced Economic Growth in the long run. This could be attributed to high level of political instability in the Nation over the years that must have reduced renewable energy supply in the country. These findings corroborate that of Safdari (2013) and Omojolaibi (2010) in their report. FOF, HCP, and TOPN insignificantly reduced Economic Growth in the long run. It can also be inferred from the result that the greenhouse gas emission technology employed in Egypt is effective in mitigating consumption and production gas emission in the long run.

Generally, in table 4.36 (total sample), the one year lag of EG(-1) considered has significant positive effect on the current year Economic Growth in the selected Africa countries. All variables are correctly signed but they are not significant at 5% confidence level in the short run. In the long run, only HCP is not signed correctly and only CO_2 and TOPN are significant at 5% confidence level. This indicates that a percentage increase in all the explanatory variables will insignificantly increase Economic Growth in the short run. In the long run, a unit increase in TOPN significantly increases Economic Growth by 10% approximately. Also a unit increase in CO_2 significantly reduced Economic Growth in Africa by 3.67 units in the long run. The mixed effect of CO_2 in both short and long run period is in accordance with EKC *U*-Shape proposition. Thereby this result confirmed the validity of EKC hypothesis in Africa region. These findings conform to that of Asici and Acar (2016) in 116 countries. Jardon, Kuik and Tol (2017) in 20 Latin American, and Caribbean countries, Olubusoye and Dasauki (2018) in 20 African countries.

Similarly, a unit increase in FOF and ELC may increase Economic Growth in a non-significant manner and HCP unit increase will reduce Economic Growth insignificantly. The behaviour of HCP is not unconnected to high level of illiteracy and brain drain that are endemic in the region. The results further show that the EKC hypothesis is valid in Africa especially with respect to consumption carbon emission (CO_2). This implies greenhouse gas emission technology and policies embraced in the region is more effective and in the right direction in curtailing the adverse effect of carbon emission thereby promoting sustainable healthy environment in the region. Specifically, this position is also confirmed in three (3) out of five (5) countries (Nigeria, Algeria, and Egypt) sampled. Except for Libya where EKC hypothesis is confirmed in production carbon emission (FOF). In both country specific analysis and general sample analysis feedback effect between the variables considered in the model is not detected. Hence, feedback hypothesis was supported via the unidirectional causality between total CO_2, FOF and Economic Growth in the entire analysis.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter focused on the summary of findings of the study, conclusion and recommendations. The study's contributions to knowledge and area of future study were also addressed in this chapter.

5.2 Summary of Findings

This study examined the effect of carbon footprint on economic growth of some selected African countries from 1980 to 2023 to confirm the validity of the EKC hypothesis. The ECM and panel VECM were employed to analyse the data sourced from the World Bank Development Index (WBDI) database. Findings point out that carbon footprint and other variables considered have different degree of significant effect on Economic Growth in each sample country in particular and African region at large. Specifically among other things findings show that:

1. in Nigeria, consumption carbon emission (CO_2) has significant positive effect on Economic Growth in the short run and significant negative effect on EG in the long run. Thereby confirmed the validity of the EKC hypothesis in Nigeria. While ELC, HCP, and TOPN were identified as the major channels through which renewable energy technology affects growth in Nigeria. However, production carbon emission (FOF) fails to toll this line;
2. in Angola, CO_2 has significant inverse effect on Economic Growth both in the short and long run period. Thus, the EKC hypothesis does not hold absolutely in Angola for consumption (CO_2) and production (FOF) carbon emission. While ELC is perceived

as main channel via which renewable energy technology affects Angola's Economic Growth and reduced CO_2 emission;

3. CO_2 has non-significant positive impact on Economic Growth in the short run and a significant negative effect on Economic Growth in Algeria. Thereby confirming the validity of EKC hypothesis in Algeria while ELC and HCP is a veritable tool through which renewable energy impact Algeria's Economic Growth. Trade openness (TOPN) in Algeria is not significantly beneficial both in the short and long run period;
4. in Libya, carbon emission (CO_2 and FOF) increased Economic Growth in the short run and only the effect of CO_2 is significant. The effect of FOF on Economic Growth in the long run is negative and insignificant while CO_2 has significant positive effect on Economic Growth in the long run. The EKC hypothesis is confirmed in Libya but it does not occupy the first order determinant in sustainable environmental development strategy. ELC, HCP, and TOPN serve as a conduit through which renewable energy technology affects Libya Economic Growth;
5. in Egypt, CO_2 has significant positive effect on Economic Growth in the short run and significant negative effect on Economic Growth in the long run. The inverted *U*-Shape is confirmed in Egypt and ELC serve as a significant channel through which renewable energy affect Egypt Economic Growth;
6. finally, CO_2 in Africa has a non-significant positive effect on the region Economic Growth in the short run and a significant negative effect on Economic Growth in the long run, thus the EKC hypothesis is confirmed in Africa. TOPN is a major channel through which renewable energy technology affects the region Economic Growth.

5.3 Conclusion

Reduction in Green House Gas (GHG) via fossil fuel burning reduction emission is a fundamental climate change strategy which has become a global objective to prevent and avoid harmful climate change by reducing carbon emissions by 2050 to net-zero emissions and Africa is not left out. Industrialized nations dominated historical emissions and energy consumption in emerging economies is on the increase which may soon exceed industrialized nation emission. The EKC theory postulated that pollution increases due to intensive industrial production. However, the industrial heavy pollution is eliminated with time and higher income levels supporting a high technological and service-centralized production, this development will mitigate and drop pollution level to have an inverted *U*-shape curve. This study explores the effect of carbon footprint on the Economic Growth (EG) of selected African countries.

Quarterly time series data and panel data of five (5) African countries from 1980 to 2023 were collected from the World Bank Development Index (WBDI) database. Statistical and econometric techniques of descriptive statistics, correlation analysis, stationarity test, co-integration test, Error Correction Model (ECM), and panel Vector Error Correction Model (VECM) were employed to analyse the data. Findings show that four (4) out of five countries traded-off EG to reduce carbon emissions in the long run. Thus, EKC proposition is confirmed in these countries (Nigeria, Algeria, Libya, and Egypt). Also, electricity consumption, human capital, and trade openness are significant channels via which renewable energy technology may affects the country's Economic Growth although in different magnitude. In Africa, EG must be traded-off in the long run to reduce the quantum of consumption carbon emission (CO_2) in the long run. Only trade openness is identified as a significant conduit via which renewable energy technology impact the region Economic Growth. From the foregoing analysis, the study concludes that better EKC hypothesis practice and favourable trade openness is a useful tool for preventing environmental degradation process and promoting economic growth and development in Africa.

5.4 Recommendation

Based on the findings, the following recommendations were made;

1. Policies that ensure efficiency in energy use should be enacted by countries in the region to curtail CO_2 emissions and promote environmental sustainability.
2. Government should be strict about environmental protection regulation practices in oil producing state in Africa.
3. Government should create the enabling trade and investment environment to encourage favourable terms of trade in the region.
4. Literacy level and human capital development should be increased by more investment in education and continuous training.
5. There is need to grow skills in utilization, creation and funding of green projects. And, to replace coal in industry and consumption.
6. Renewable energy consumption is beneficial to the region economic growth thus, government should invest more in the technology to ensure sustainable environment in the long run.
7. The government should immediately improve the provision of a more environmentally friendly non-fossil energy source as countries in other continent are gradually heavily dependent on non-fossil energy sources.
8. The need to efficiently use oil revenues to create alternative revenue yielding projects as done by some OPEC countries before demand seizes to exist.
9. Depletion premium estimation should be implemented because oil is wasting assets which cannot be renewed or replaced.
10. Finally, household, corporate bodies and government also need to be encouraged to use cleaner energy sources and save energy use in daily activities.

5.5 Contribution to Knowledge

This study made the following contributions:

1. the recency of this study being one of the few studies to use quarterly time series and panel data to examine the effect of carbon footprint on economic growth of the five (5) largest oil producing country in Africa. Study of the nature has not been done in Nigeria to the best of my knowledge;
2. the study uniquely used ECM and panel VECM technique considering consumption carbon emission (CO_2), production carbon emission (FOF), human capital, electricity consumption, and trade openness to ascertain the validity of EKC hypothesis in Africa. An aspect of research that has been largely ignored in the literature;
3. the study advanced knowledge frontier being the first to empirically indicate that EKC hypothesis is majorly valid in consumption carbon emission (CO_2) and not production carbon emission;
4. the study contribute to existing theory and empirical studies especially in emerging region like Africa by investigating the effect of carbon footprint on economic growth from EKC perspective.

5.6 Future Studies

1. The model underlying this study should be extended beyond Africa to Asia, Europe and America in order to have comparative findings that can be generalized.
2. Other proxy of carbon emission like different component of fossil fuel (coal, oil among others) should be adopted and estimated with sophisticated techniques like the dynamic OLS, Mean Group (MG) and Pool Mean Group (PMG) this might reveal new information.

References

Abbasi, F., & Riaz, K. (2016). CO_2 emissions and financial development in an emerging economy: An augmented VAR approach. *Energy Policy, 90(c)*, 102–114.

Abington, T., & Gilblom, K. (2019). Shell leads big oil in the race to invest in clean energy. *Bloomberg*. *4*, 5-19.

Abouie-Mehrizi, M., Atashi, S.M., & Elahi, M. (2012). Effect of population growth, urbanization and economic growth. .*African Journal of Business Management*, *6*(28), 8414-8419.

Acheampong, A.O., Dzator, J. & Savage, D.A. (2021). Renewable energy, CO2 emissions and economic growth in sub-Saharan Africa: Does institutional quality matter?. *J Policy Model*, *43*(5), 1070–1093. https://doi.org/10.1016/j.jpolmod.2021.03.011

Acheampong, A.O. & Osei Opoku, E.E. (2022). Environmental degradation and economic growth: Investigating linkages and potential pathways. *Energy Economics*, *123*(4), 2-23.

ADB (2014). Ouarzazate solar complex project – Phase II (NOORo II and NOORo III Power Plants. Abidjan: African Development Bank.

Adeleye, B.N., Osabohien, R., Lawal, A.I., & De Alwis, T. (2021). Energy use and the role of per capita income on carbon emissions in African countries. *PLoS One*, *16*(11):e0259488. https://doi.org/10.1371/journal.pone.0259488

Advancing Africa with renewable energy auctions (2018). International renewable energy agency. *Energy Journal*, *6*, 2-23.

Agenor, P.R. (2004). Does globalization hurt the poor? *Policy Research Paper*, *1*(1), 21–51.

Aghion, P., Howitt, P., & Mayor-Foulkes, D. (2005). The effect of financial development on convergence: Theory and evidence. *Quantitative Journal of Economics*, *120*(1), 173–222.

Ahmad, W., Majeed, T., & Andlib, Z. (2019). Tourism led growth hypothesis: Empirical evidence from five South Asian countries. *Journal of Bulletin of Business and Economics (BBE), 9*(1), 51-59.

Ahmed, K., Rehman, M. U., & Ozturk, I. (2017). What drives carbon dioxide emissions in the long-run? Evidence from selected South Asian Countries. *Renewable and Sustainable Energy Reviews, 70(6)*, 1142–1153.

Akadiri, S.S., Bekun, F.V., Taheri, E., & Akadiri, A.C. (2019). Carbon emissions, energy consumption and economic growth: A causality evidence. *International Journal of Energy, Technology and Policy*, *15*(2/3), 320–336.

Akoena S., & Agyire-Tettey, M.G. (2007). Energy consumption and economic growth: Evidence from Ghana. *West Africa Journal Monetary Economic Integration*, *7(2)*, 91–119.

Alam, M.B. & Hossain, M.S. (2024). Investigating the connections between China's economic growth, use of renewable energy, and research and development concerning CO_2 emissions: An ARDL Bound Test Approach. *Technological Forecasting and Social Change*, *201*, 18-39.

Alege, P.O., Adediran, O.S., & Ogundipe, A.A. (2016). Pollutant emission, energy consumption and economic growth in Nigeria*. International Journal of Energy Economics and Policy*, *6*(2), 202-207.

Al-Iriani, M. (2006). Energy–GDP relationship revisited: An example from GCC countries using panel causality. *Energy Policy*, *34(17),* 3342–3350.

Ali, M., & Kirikkaleli, D. (2022). The asymmetric effect of renewable energy and trade on consumption-based CO_2 emissions: The case of Italy. *Integr Environ Asses Manag, 18*(3),784–795. https://doi.org/10.1002/ieam.4516

Almeida, R., & Fernandes, A. (2008). Openness and technological innovations in developing countries: Evidence from firm-level surveys. *Journal of Developmental Studies*, *44*(5), 701–727.

Al-mulali, U., Tang, C. F., & Ozturk, I. (2015). Estimating the environment Kuznets curve hypothesis: Evidence from Latin America and the Caribbean countries. *Renewable and Sustainable Energy Reviews, 50(C)*, 918–924.

Ang, J.B. (2009). CO_2Emissions, research and technology transfer in China. *Ecological Economics*, 68(10), 2658-2665.

Antonakakis, N., Chatziantoniou, I., & Filis, G. (2017). Energy consumption, CO_2 emissions, and economic growth: An ethical dilemma. *Renewable and Sustainable Energy Reviews, 68(1)*, 808–824.

Apergis, N., & Payne, J. (2010). Renewable energy consumption and growth in Eurasia. *Energy Economics*, *32(6)*, 1392-1397.

Apergis, N., & Payne, J. (2010). Renewable energy consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy, 38*(1), 656-660.

Apergis, N., & Payne, J. (2011). Renewable and non-renewable energy consumption-growth nexus: Evidence from emerging market economics. *Applied Energy*, *88(12)*, 5226-5230.

Apergis, N., & Payne, J. (2011). The renewable energy consumption – growth nexus in Central America.*Applied Energy Elsevier*, *88(1)*, 343-347.

Apergis, N., & Payne, J. (2012). Renewable and non-renewable energy consumption-growth nexus: Evidence from a panel error correction model. *Energy Economics*, *34(3)*, 733-738.

Aqeel, A., & Butt, M.S. (2001). The relationship between energy consumption and economic growth in Pakistan. *Asia Pacific Development Journal*, *8(2)*, 101–110.

Ariayefa, F.E., Ebimowei, W., & Anda-Owei, J.P. (2023). Human capital development and economic growth: Evidence from Nigeria. *Asian Journal of Economics, Business and Accounting*, *23*(21), 96-110.

Asici, A.A., & Acar, S. (2015). Does income growth relocate ecological footprint. *Journal of Ecological Indicator*, *61*(2), 707-714.

Aslan, A. (2013). Energy consumption and GDP: The strong relationship in OECD countries. *Journal Energy Sources, Part B: Economics, Planning, and Policy*, *8*(4), 339-345.

Attahir, B.A., Ahmad, S.B., & Abdullahi, A.M. (2020). To what extent does human capital development impact economic growth? Empirical evidence from Nigeria. *Research Square*, *1*, 1–21.

AU (2010). Agenda 2063 2015 the Africa we want African Union. Retrieved from www.africanunion.org 16/7/2021.

Awodumi, O. B., & Adewuyi, A. O. (2020). The role of non-renewable energy consumption in economic growth and carbon emission: Evidence from oil producing economies in Africa. *Energy Strategy Reviews*, *27*, 100434.

Ayadi, F.S. (2014). Economic integration, growth and the environment in Africa: A study of Nigeria. *Journal of Emerging Issues in Economics, Finance and Banking*, *3(2)*, 1274-1289.

Aye, G.C., & Edoja, P.E. (2017). Effect of economic growth on CO_2 emissions in developing countries: Evidence from a dynamic panel threshold model. *Cogent Economic & Finance Journal, 5*(13), 1-22.

Ayoade, J. O. (2003). *Climate change*. Ibadan: Vantage publishers, 128.

Ayompe, L.M., Davis, S.J., & Egoh, B.N. (2021). Trends and drivers of African fossil fuel co_2 emissions 1990–2017. *Environmental Research Letters*, *15*(2020), 2-10.

Balcilar, M., Ozdemir, Z.A., Tunçsiper, B., & Shahbaz, M. (2019). On the nexus among carbon dioxide emissions, energy consumption and economic growth in G-7 countries: New insights from the historical decomposition approach. *Environmental Development Sustainability, 3*(4), 23-41.

Bartleet, M., & Gounder, R. (2010). Energy consumption and economic growth in New Zealand: results of trivariate and multivariate models. *Energy Policy*, *38(7)*, 3505–3517.

Benhabib, J., & Spiegel, M. (2005). Human capital and technology diffusion. *Handbook of Economic Growth. Elsevier, Amsterdam*, 1(1), 935-966,

Bewket, W. (2012). Climate change perception and adaptive responses of smallholder farmers in central highlands of Ethiopia. *International Journal of Environmental Studies*, *69*(3), 507-523.

Bhatt, H., Davawala, M., Joshi, T., Shah, M., & Unmarked, A. (2023). Forecasting and mitigation of global environmental carbon dioxide emission using machine learning techniques. *Cleaner Chemical Engineering*, *5*, 2772-7823.

Bimanatya, T.E., & Widodo, T. (2018). Fossil fuels consumption, carbon emissions, and economic growth in Indonesia. *International Journal of Energy Economics and Policy*, *8*(4), 90-97.

Bloomberg NEF (2022). Scaling-up renewable energy in Africa: A netzero pathfinders report. Retrieved from: https://assets.bbhub.io/professional/sites/24/BNEF-Scaling-Up-Renewable-Energy-in-Africa-A-NetZero-Pathfinders-report_FINAL.pdf

Bolaky, B., & Freund, C. (2008). Trade, regulations, and income. *Journal of Developmental Economics*. *87*(2), 309–321.

Botkin, D. B., & Keller, E. A. (l997). *Environmental science*. New York, NY: John Willey & Sons, 245.

Bratt, L. (2012). Three totally different environmental/GDP curves. In: C. Ghenai, ed. *Sustainable Development – Education, Business and Management - Architecture and Building Construction – Agriculture and Food Security,* 283-312.

Cederborg, J., & Snobohm, S. (2016). Is there a relationship between economic growth and carbon dioxide emissions? *Institution of Social Sciences*, *4*(2), 1-41.

Chan, H.L., & Lee, S.K. (1996). Forecasting the demand for energy in China. *Energy Journal*, *17(1)*, 19–30.

Chang, T.H., Huang, C.M., & Lee, M.C. (2009). Threshold effect of the economic growth rate on the renewable energy development from a change in energy price: Evidence from OECD countries. *Energy Policy*, *37(12)*, 5796–5802.

Charfeddine, L., & Mrabet, Z. (2017). The impact of economic development and social-political factors on ecological footprint: A panel data analysis for 15 MENA countries. *Renewable and Sustainable Energy Reviews, 76(c)*, 138–154.

Chen, J.H., & Huang, Y.F. (2014). Nonlinear environment and economic growth nexus: A panel smooth transition regression approach. *Journal of International and Global Economic Studies, 7*(2), 1–16.

Cheng, B.S. (1999). Causality between energy consumption and economic growth in India: An application of co-integration and error-correction modelling. *Indian Economic Review*, *1*, 39–49.

Chertow, M. R. (2001). The IPAT equation and its variants; changing views of technology and environmental impact. *Journal of Industrial Ecology, 4(4)*, 13–29.

Chun, J. & Xiaoxin, M. (2019). The impact of financial development on Carbon emissions: A global perspective, *Sustainability Journal MDPI*, *11*(19), 5241, doi: 10.3390/su11195241.

CIF (2019). Solar plant the size of San Francisco powers Morocco's sunlit ambitions. *Climate Home News*, *22*, 19-41.

Clayton, S., Kals, E., & Feygina, I. (2016). Justice and environmental sustainability. *Handbook of social justice theory and research*, *Springer Journal*, 2(4), 369–386.

Cohen, W., & Levinthal, D. (1989). Innovation and learning: Two faces of R&D. *Economics Journal*, *99*(8), 569–596.

Corfee-Morlot, J. (2019). Achieving clean energy access in Sub-Saharan Africa Paris: OECD/. *Financing Climate Futures*, *3*(2), 45-65.

Costanza, R. (2014). Beyond GDP; The need for new measures of progress. *The Pardee Papers, No 4*, 1-13.

Cunningham, N., & Sinclair, D. (1998). Designing environmental policy. *Smart Regulation: Designing Environmental Policy,* 375-453.

Dalla Longa, F., & Vander Zwaan, B. (2017). Do Kenya's climate change mitigation ambitions necessitate large-scale renewable energy deployment and dedicated low-carbon energy policy? *Renewable Energy*, *113(c)*, 1559-1568.

Daly, H. E. (1991) *Steady-state economics* (2nd edition). San Francesco; Washington, DC: Freeman & Co.; Island Press.

Daly, H. E., & Farley, J. C. (2004). Ecological economics *(6th edition): Principles and applications. Washington, DC: Island Press*

Dahir, A.L. (2018). Africa's fastest-growing cities are the most vulnerable to climate change globally. *World Economic Forum*, *21*, 12-34.

Dansofo, A.T, Zakaree S. S., Anfofum A.A., Mustapha, M., Suleiman, S., Yakubu A., Dampome, M., Ibubor, J.O., Gambo J.S., & Ojo, S. (2024). Impact of non-renewable energy consumption and economic growth on carbon emission in Nigeria. *ABUAD Journal of Social and Management Sciences*, *5*(1), 94-119.

Dirk Rottgers, A.P., & Scherrer, I. (2018). State-owned enterprises and the low-carbon transition, OECD Environment Working Papers 129.

Dinda, S. (2004). Environmental Kuznets curve hypothesis: A Survey *Ecological Economics, 49*(4), 431-455

Energy Information Administration (2023). Country statistics. Retrieved from www.internationalenergyagency.com 21/11/2023.

Edoja, P. E., Aye, G. C., & Abu, O. (2016). Dynamic relation among CO_2 emissions, agricultural productivity and food security in Nigeria. *Cogent Economics and Finance, 4*, 1204809.

Egbulonu, K.G. & Adaku, E. J. (2018). trade openness and Nigeria's economic growth (1990- 2015). *International Journal of Development and Economic Sustainability*, *6*(3), 1-11.

Egbunike, F. C., Emudainohwo, O. B., & Gunardi, A. (2018). Tax revenue and economic growth: A study of Nigeria and Ghana. *Signifikan: Jurnal Ilmu Ekonomi*, *7*(2), 213-220.

Ejuvbekpokpo, S.A. (2014). Impact of carbon emissions on economic growth in Nigeria. *Asian Journal of Basic and Applied Sciences*, *1*(1), 15-25.

Elom, C.O., Onyeneke, R.U., Ankrah, D.A., Deffor, E.W., Ayerakwa, H.M. & Uwaleke, C.C. (2024). Achieving carbon neutrality in Africa is possible: The impact of education, employment, and renewable energy consumption on carbon emissions. *Journal of Carbon Research*, *3*(24), 1-15.

Engle, C. W. J., & Granger. (1987). The relationship between cointegration and error correction models . *55*(2), 251-276.

Emissions Gap Report (2024). United nation environmental programme. Retrieved from: https://www.unep.org/resources/emissions-gap-report-2024?gad_source=1&gclid=CjwKCAjwg-24BhB_EiwA1ZOx8jDgs_8CPvbQ0bsu3LhWXO-7uY5K_PcD-yBfdy-DYmoP5A-2kwOgGRoCJsoQAvD_BwE

Ericsson, N.R. (2016). Eliciting GDP forecasts from the FOMC's minutes around the financial crisis. *International Journal of Forecasting*, *32*(2), 571-583.

Field, B. C., & Field, M. K. (2013). *Environmental Economics - An introduction.* 6 ed. New York: McGraw-Hill Education.

Fosu, A.K. (1990). Exports and economic growth: the African case. *World Development*, *18(6)*, 831–835.

Garba, P.M. (2011). The effect of industrialization on the environment. Cambridge: MIT Press.

Gasparatos, A., Doll, C. N. H., Esteban, M., Ahmed, A., & Olang, T. A. (2017). Renewable energy and biodiversity: Implications for transitioning to a Green Economy. *Renewable and Sustainable Energy Reviews*, *70(c)*, 161-184.

Global Commission on the Economy and Climate (2018). Unlocking the inclusive growth story of the 21st century: Accelerating climate action in urgent times. (5th Ed), Washington D.C. New Climate Economy.

Greiner, A., Gruene, L., & Semmler, W. (2012). Economic growth and the transition from non-renewable to renewable energy. *Environment and Development Economics*, 19(4), 1-34.

Grossman, G., & Krueger, A. (1995). Economic growth and the environment. *The Quarterly Journal of Economics*, *110(2)*, 353-377.

Grossman, G.M., & Krueger, A.B. (1991). Environmental impacts of a North American free trade agreement. NBER Working Paper No. 3914.14-23.

Gruzina, Y., Firsova, I., & Strielkowski, W. (2021). Dynamics of human capital development in economic development cycles. *Economies*, *9*(67), 1-18.

Gur, T.M. (2022). Carbon dioxide emissions, capture, storage and utilization: review of materials, processes and technologies. *Progress in Energy and Combustion Science*, *89*, 100965.

Haller, A. (2012). Concepts of economic growth and development. Challenges of crisis and of knowledge. *Economy Transdisciplinarity Cognition*, *15*(1), 66-71.

Hamilton, T.G.A., & Kelly, S. (2017). Low carbon energy scenarios for Sub-Saharan Africa: An input-output analysis on the effects of universal energy access and economic growth. *Energy Policy, 105*, 303–19.

Haltiwanger, J. (2011). Firm dynamics and productivity growth. *European Investment Bank. 16*(1) , 116-136.

Heidari, H., TuranKatircioglu, S., & Saeidpour, L. (2015). Economic growth, CO_2 emissions, and energy consumption in the five ASEAN countries. *International Journal of Electrical Power & Energy Systems, 64(0)*, 785–791.

Herscowitz, A. (2018). The unintended consequences of falling solar prices in Africa. Medium, May 23.

Herzer, D. (2013). Cross-country heterogeneity and the trade-income relationship. *World Development*, *44(c)*, 194–211.

Hettige, H., Dasgupta, S., & Wheeler, D. (2000). What improves environmental compliance? Evidence from Mexican industry. *Journal of Environmental Economics and Management, 91*(1), 39–66.

Huang, B., Hwang, M.J., & Yang, C.W. (2008). Causal relationship between energy consumption and GDP growth revisited: A dynamic panel data approach, *Ecological Economics*. *67(1)*, 41–54.

Hsiao, C. (1985). Benefits and Limitations of Panel Data. *Econometric Reviews*, 4, 121-174.
Kao, C. (1999). Spurious regression and residual based test for co-integration in panel data. *Journal of Econometrics*, 90(3), 1-44.

Huesemann, M. H., & Huesemann, J. A. (2011). *Technofix: Why technology won't save us or the environment, Chapter 6, sustainability or collapse?* Vancouver: new society publishers, 2011.

Hwang, J., & Yoo, S. (2012). Energy consumption, CO_2emissions, and economic growth: Evidence from Indonesia. *Quality and Quantity*, *48*(1), 63-73.

IPCC (2007). Climate change 2007: synthesis report. Cambridge: Cambridge, 27-70.

IPCC (2018). Global warming of 1.5 ◦C An IPCC special report on the impacts of global warming of 1.5 ◦C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, (ed) V Masson-Delmotte *et al*

IPCC (2022). Climate change 2022: impacts, adaptation, vulnerability. Available at: https://www.un.org/en/climatechange/reports?gad_source=1&gclid=EAIaIQobChMIgayegLOihwMVVJRQBh38hAtnEAAYASAAEgIeP_D_BwE 3/6/2024

Ishida, H. (2011). Causal relationship between fossil fuel consumption and economic growth in Japan: A multivariate approach. *Discussion Papers in Economics and Business*, 11-13.

Jafari, Y., Othman, J., & Nor, A.H.S.M. (2012). Energy consumption, economic growth and environmental pollutants in Indonesia. *Journal of Policy Modelling*, *34*(6), 879-889.

Jardon, A., Kuik, O., & Tol, R.S.J. (2017). Economic growth and carbon dioxide emissions: An analysis of Latin America and the Caribbean. *Atmósfera, 30*(2), 87-100.

Johansen, S. (1991). Estimation and hypothesis testing of co-integration vectors in gaussian vector autoregressive models. *Econometrica*, *59*, 1551-1580.

Johnson, D. L., Ambrose, S. H., Bassett, T. J., Bowen, M. L., Crummey, D. E., Isaacson, J. S., & Winter-Nelson, A. E. (1997). Meanings of environmental terms. *Journal of Environment Quality, 26(3)*, 581–589.

Kahia, M., Aissa, M. S. B., & Charfeddine, L. (2016). Impact of renewable and non-renewable energy consumption on economic growth: New evidence from the MENA Net Oil Exporting Countries (NOECs). *Energy, 116(p1)*, 102–115.

Kahia, M., Aissa, M. S. B., & Lanouar, C. (2017). Renewable and non-renewable energy use - economic growth nexus: The case of MENA Net Oil importing countries. *Renewable and Sustainable Energy Reviews, 71(c)*, 127–140.

Kais, S., & Ben Mbarek, M. (2017). Dynamic relationship between CO_2 emissions, energy consumption and economic growth in three North African countries. *International Journal of Sustainable Energy, 36(9)*, 840–854.

Kao, K. C. (1991). A memoir; A choice fulfilled: *The Business of High Technology.* 55-60

Karambakuwa, T., Ncwadi, R., & Phiri, A.(2019). The human capital – economic growth nexus in SSA countries: What can strengthen the relationship? Munich Personal RePec Archive.

Kasman, A., & Duman, Y. S. (2015). CO_2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: A panel data analysis. *Economic Modelling, 44(c)*, 97–103.

Khan, M.K., Khan, M.I., & Rehan, M. (2020).The relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. *Financial Innovation Journal, 6*(1), 2-21.

Klevmarken, N.A. (1989). Fiscal incentives and direct foreign investment in less developed countries. *The Journal of Development Studies*, *9(2)*, 207-212.

Komen, R., Gerking, S., & Folmer, H. (1997). Income and environmental R&D: Empirical evidence from OECD countries. *Environment and Development Economics, 2*(4), 505-515.

Kraft, J., & Kraft, A. (1978), On the relationship between energy and GNP. *Journal of Energy and Development*, *3(2)*, 401-403.

Krueger, A., & Berg, A. (2003). Trade, Growth, and poverty: A selective survey. IMF working paper, WP/03/30.*International Monetary Fund*, Washington.

Kuznets, S., (1955). Economic growth and income inequality. *The American Economic Review, 45*(1), 1-28.

Leal, P.H. & Marques, A.C. (2022). The evolution of the environmental Kuznets curve hypothesis assessment: A literature review under a critical analysis perspective. *Heliyon*, *118*(11), e11521.

Lee, C.C. (2005). Energy consumption and GDP in developing countries: A co integrated panel analysis. *Energy Economics*, *27*(3), 415–427.

Leitão, J., Ferreira, J., & Santibanez-González, E. (2022). New insights into decoupling economic growth, technological progress and carbon dioxide emissions: Evidence from 40 countries. *Technological Forecasting and Social Change*, *174*, 121250.

Lequiller, F., & Blades, D. (2006). *Understanding National Accounts.* Paris: OECD Organization for Economic Co-operation and Development, 8-21.

Li, F., Dong, S., Li, X., Liang, Q., & Yang, W. (2011). Energy consumption-economic growth relationship and carbon dioxide emissions in China. *Journal of Energy Policy*, *39(2)*, 568–574.

Liang, Z. (2006). Threshold estimation on the globalization poverty nexus: Evidence from China. Research paper, UNU-WIDER United Nations University (No. 2006/57).

Lucas, R.E. (1988). On the mechanic of economic development. *Journal of Monetary Economics*, *46*(1), 167–182.

Magazzino, C. (2016). CO_2 emissions, economic growth, and energy use in the Middle East countries: A panel VAR approach. *Energy Sources, Part B: Economics, Planning, and Policy, 11(10)*, 960–968.

Mardani, A., Jusoh, A., Nor, K., Khalifah, Z., Zakwan, N., & Valipour, A. (2015). Multiple criteria decision-making techniques and their applications – a review of the literature from 2000 to 2014.*Economic Research*, *28*(1), 516-571.

Mesagan, E.P. (2015). Economic growth and carbon emissions in Nigeria. The IUP Journal of Applied Economics 14 (4), 61-75.

Mohamed, T., Shaaban, M., Azza, T., & Mowafy, E. I. (2012). Production of some biopolymers by some selective Egyptian soil bacterial isolates. *Journal of Applied Sciences Research, 8(1)*, 94–105.

Mohammadi, M.S., & Mohammadi, H. (2013). Energy as a causality of growth in oil exporting countries? Panel co-integration and causality tests for OPEC countries. *American International Journal of Research in Humanities, Arts and Social Sciences, 4*(2), 177-184.

Musa, N. (2020). Impact of trade openness and exchange rate volatility on economic growth in Nigeria. *Interdisciplinary Journal of African and Asian Studies (IJAAS)*, *6*(2), 185-195.

Nickolas, S. (2019). What is the relationship between human capital and economic growth. *Eurasian Journal of Economics and Finance, 8(2), 115-129*

Ntombela, S.M., Bohlmann, H.R., & Kalaba, M.W. (2019). Greening the South Africa's economy could benefit the food sector: Evidence from a Carbon Tax Policy Assessment. *Environmental and Resource Economics*, *74*(2), 891-910.

Nwachukwu T. E., & Egwaikhide, F. O. (2007). An Error-Correction Model of the determinants of private saving in Nigeria. A paper presented at the African Economic Society (AES) Conference, Cape Town, South Africa, July, 2007.

Odemba, (2011). The impact of carbon emissions on economic growth. *Journal of Economic and Finance*, *2*(1), 23-39.

Olarinde, M., Martins, I., & Abdulsalam, S. (2014). An empirical analysis of the relationship between CO_2emissions and economic growth in West Africa. *America Journal of Economics*, *4(1),* 1-17.

Olayiwola, O.S., Bakare-Aremu, A.T., Abiodun, O.S. (2021). Public health expenditure and economic growth in Nigeria: Testing of Wagner's hypothesis. *African Journal of Economic Review*. *9*(2), 130–150.

Olubusoye, O., & Dasauki, M. (2018). Carbon emissions and economic growth in Africa. Munich Personal RePEc Archive (MPRA) Paper, 96159, 1-13.

Omojolaibi, J.A. (2010). Environmental quality and economic growth in some selected West African countries. *Journal of sustainable development*, *12*(8), 35-48.

OPEC (2023). List of countries by oil producing countries. Retrieved from: https//en.m.Swikipedia.org/List of countries by oil producing countries. 21/11/2023.

Osadume, R., & Edih, O. (2021). Impact of economic growth on carbon emissions in selected West African countries, 1980–2019. *Journal of Money and Business*, *1*(1), 8-23.

Osuntuyi, B.V., & Lean, H.H. (2023). Environmental degradation, economic growth, and energy consumption: The role of education. *Sustain. Develop*, *31*(2), 166-1177.

Oyefabi, I. S., & Tukur, M. U. (2019). Trade openness and economic growth in the developing countries: Evidence from Nigeria. *International Journal of Academic Research in economics and management sciences*, *8*(3), 31-42.

Ozturk, F. (2017). Energy consumption–GDP causality in MENA countries. *Energy Sources, Part B: Economics, Planning, and Policy*, *12*(3), 231-236.

Ozturk, I., & Acaravci, A. (2010). CO_2 emissions, energy consumption and economic growth in Turkey. *Renewable and Sustainable Energy Review*, *14*(9), 3220-3225.

Ozturk, I., & Al-Mulali, U. (2015). Natural gas consumption and economic growth nexus. Panel data analysis for GCC countries. *Renewable and Sustainable Energy Reviews*, *51(c)*, 998-1003.

Ozturk, I. (2010). A literature survey on energy–growth nexus. *Energy Policy*, *38*(1), 340-349.

Panayotou, T. (1993). Empirical tests and policy analysis of environmental degradation at different stages of economic development. *Working paper, 5(2),* 3-7.

Pata, U.K., & Kartal, M.T. (2023). Impact of nuclear and renewable energy sources on environment quality: Testing the EKC and LCC hypotheses for South Korea. *Nucl Eng Technol*, *55*(2), 587–594. https://doi.org/10.1016/j.net.2022.10.027

Pedroni, P. (1999). Critical values for co-integration test in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, *61(2)*, 653-678.

Phimphanthavong, H. (2013). The impacts of economic growth on environmental conditions in Laos. *International Journal of Business Management and Economic Research, 4(5)*, 766–774.

Potters, C., & Munichiello, K. A. (2024) Economic growth: What it is and how it is measured. Retrieved from: https://www.investopedia.com/terms/e/economicgrowth.asp. 15/9/2024

Quadrelli, R., & Peterson, S. (2007). The energy-climate challenge: Recent trends in co_2 emissions from fuel combustion. *Energy Policy*, *35*, 5938–52.

Rafiq, S., & Salim, R. (2011). The linkage between energy consumption and income in six Asian emerging economies: An empirical analysis. *International Journal of Emerging Market*, *6*(1), 50-73.

Randelovic, M.P., & Zdravkovic, A. (2019). Economic growth and carbon emissions: Evidence from CIVETS countries. *Journal of Applied Economics*, *52*(16), 1806-1815.

Roca, J., (2003). Do individual preferences explain the Environmental Kuznets curve? *Ecological Economics, 45*(1), 3-10.

Safdari, M., Barghandan, A., & Shaikhi, A. M. (2013). Has CO_2 emission increased the Iranian economic growth? *International Journal of Academic Research in Business and Social Sciences*, *3*(1), 314-352.

Sahir, M. H., & Qureshi, A. H. (2007).Specific concerns of Pakistan in the context of energy security issues and geopolitics of the region. *Energy Policy, 35(4)*, 2031–2037.

Salahuddin, M., Habib, M.A., Al-Mulali, U., Ozturk, I., Marshall, M. & Ali, M.I. (2020). Renewable energy and environmental quality: A second-generation panel evidence from the Sub Saharan Africa (SSA) countries. *Environ Res*, *1*(91), 12-34. https://doi.org/10.1016/j.envres.2020.110094

Saidi, K., & Hammami, S. (2015). The impact of CO_2 emissions and economic growth on energy consumption in 58 countries. *Energy Reports, 1(2)*, 62–70.

Salahuddin, M., Gow, J., & Ozturk, I. (2015). Is the long-run relationship between economic growth, electricity consumption, carbon dioxide emissions and financial development in Gulf Cooperation Council Countries robust? *Renewable and Sustainable Energy Reviews, 51(2)*, 317–326.

Sarwar, S., Alsaggaf, I.M., & Tingqiu, C. (2019). Nexus among economic growth, education, health, and environment: Dynamic analysis of world-level data. *Journal of Frontier Public Health*, *7*(309), 3-19.

Schroder, E., & Storm, S. (2018). Economic growth and carbon emissions: The road to hot house earth is paved with good intentions. *Institute for New Economic Thinking, Working Paper 49(2), 2-39.*

Selin, N.E. (2020). Carbon footprint. *International Journal of Agricultural Science and Research (IJASR), 11(3), 91–105.*

Shafik, N. (2002). Economic growth and environmental quality: Time series and Cross-country evidence. *Policy Research Working Paper Series 904*, The World Bank.

Shahbaz, M., Nasreen, S., Ahmed, K., & Hammoudeh, S. (2017). Trade openness–carbon emissions nexus: The importance of turning points of trade openness for country panels. *Energy Economics, 61(7)*, 221–232.

Shahzad, U., Mohammed, K.S., Schneider, N., Faggioni, F., & Papa, A. (2023). GDP responses to supply chain disruptions in a post-pandemic era: Combination of DL and ANN outputs based on Google Trends. *Technological Forecasting and Social Change*, *192*(3), 12-24.

Shuaibu, M.I., & Oyinlola, M.A. (2013). Energy consumption, CO_2emissions and economic growth in Nigeria. *Paper Presented at the 2013 NAEE International Conference*, Lagos.

Sindzingre, A., 2005. Explaining threshold effects of globalization on poverty: An Institutional Perspective Research Paper. UNU-WIDER United Nations University (No. 2005/53).

Singh, T. (2010). Does international trade cause economic growth? A survey. *World Economy*, *33*(11), 1517–1564.

Smulders, S. (2000). *Economic growth and environmental quality. Principles of environmental and resources economics*. HenkFolmer and LadisGabel (eds), Edward Elgar, 1-15.

Soava, G., Mehedintu, A., Sterpu, M., & Raduteanu, M. (2018). Impact of renewable energy consumption on economic growth: Evidence from European Union countries. *Technological and Economic Development of Economy*, *24*(3), 914-93.

SolaNow, N. (2019). High solar solution. Retrieved from https://www.solarnow.eu.15/7/2021

Solon, G.S. (1989). *The value of Panel Data in Economic Research*. New York: Wiley.

Solow, R. (1957). Technical change and the aggregate production function. *Rev. Econ. Stat. 39(3)*, 312–320.

Stephen, H. (2016). Shock waves: Managing the impacts of climate change on poverty. Washington D.C.: World Bank.

Stern, D.I. (2004). The rise and fall of the environmental Kuznets curve. *World Development, 32*(8), 1419–1439.

Stern, D.I. (2004). Environmental Kuznets curve. *Science Direct*, Retrieved from: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/environmental-kuznets-curve. 4/11/2024.

Stern, D.I., & Kander, A. (2012). The role of energy in the industrial revolution and modern economic growth. *Energy Journal*, *33*(3), 1-11.

Stern, D.I. (2003). The Rise and fall of the environmental Kuznets curve. Rensselaer: Working Papers in Economics, 0302.

Stern, D.I. (2011). The role of energy in economic growth. *Annals of the New York Academy of Sciences*, *1219*(1), 26-51.

Sunday, E., &Ahmed, B. M. (2019). Dynamic impact of trade openness on the economic growth in Nigeria. *International Journal of Engineering and Advanced Technology (IJEAT)*, *8*(5C), 609-616.

Tajudeen, I.A. (2015). Examining the role of energy efficiency and non-economic factors in energy demand and co_2 emissions in Nigeria: Policy implications. *Energy Policy, 86,* 338–50.

Trading Economics (2023). List of oil producing countries in Africa. Retrieved from: https://tradingeconomics.com/country-list/crude-oil-production? continent =africa

Trejos, S., & Barboza, B. (2015). Dynamic estimation of the relationship between trade openness and output growth in Asia. *Journal of Asian Economic*, *36*(2015), 110–125.

Tsaurai., K. & Ndou, A. (2019). Infrastructure, human capital development and economic growth in transitional countries. *Comparative Economic Research. Central and Eastern Europe. De Gruyter,Warsaw*, *22*(1):33-52.

Tutulmaz, O. (2015). Environmental Kuznets curve time series application for Turkey: Why controversial results exist for similar models? *Renewable and Sustainable Energy Reviews, 50(5)*, 73–81.

Tyokosu, M.A., & Abakpa, N. (2023). The relationship between trade openness and economic growth in Nigeria from 2000 to 2020. *International Journal of Research and Innovation in Social Science (IJRISS)*, *7*(11), 1766-1778.

Uddin, G. A., Salahuddin, M., Alam, K., & Gow, J. (2017). Ecological footprint and real income: Panel data evidence from the 27 highest emitting countries. *Ecological Indicators, 77(3)*, 166–175.

Ulasan, B. (2015). Trade openness and economic growth: Panel evidence. *Applied Economics. Letters*, *22*(2), 163–167.

Umar, B., Hawwa, A. A., Nazeef, B. H. & Yahaya Y.M. (2021). Impact of trade openness on economic development in Nigeria. *International Journal of Intellectual Discourse (IJID)*, *4*(2), 303-312.

UNFSCC (2006). Africa is particularly vulnerable to the expected impacts of global warming. *United Nation Climate Change Conference, Nairobi*, Kenya, *1*, 1-3.

UNFCCC (2014). United Nations development reports. Library of Congress Cataloging-in-Publication Data, 12-24.

UNFCCC (2015). United Nations 2015 framework convention on climate change Paris agreement.

UNDESA (2019). World population prospects 2019: Highlights. United Nations, Department of Economic and Social Affairs, Population Division. Retrieved from www.uno.org. 17/7/2021.

United Nations [UN] (2014, 2023). Causes and effects of climate change Available at: https://www.un.org/en/climatechange/science/causes-effects-climate-change#:~:text=Fossil%20fuels%20%E2%80%93%20coal%2C%20oil%20and,they%20trap%20the%20sun's%20heat.2/6/2024.

Vitality, I.O. (2023). How is carbon footprint different from ecological footprint. Retrieved from: https://vitality.io/how-is-carbon-footprint-different-from-ecological-footprint/amp/ 11/12/2024.

Von, P.N. (2009). Energy consumption and income: A semi-parametric panel data analysis. *Energy Economics, 32(3)*, 557–563.

Wackernagel, M., & Rees, W.E. (1996). *Our ecological footprint: Reducing human impact on the earth*. New Society Publishers: Gabriola Island, British Columbia, Canada.

Wackernagel, M., Lewan, L., & Ansson, C.B. (1999). Evaluating the use of natural capital with the ecological footprint. *Ambio, 28*(7), 604–12.

Wang, D. (2012). A dynamic optimization on energy efficiency in developing countries. *MPRA Paper No. 43749*, 12-34.

Watanabe, C., Naveed, K., Tou, Y., & Neittaanmäki, P. (2018). Measuring GDP in the digital economy: Increasing dependence on uncaptured GDP. *Technological Forecasting and Social Change*, *137*, 226-240.

Wei, W. (2002). Study on the determinants of energy demand in China. *Journal Syst. Eng. Electron*, *13(3)*, 17–23.

WMO (2023). State of global climate 2023 report. Retrieved from: https://www.un.org/en/climatechange/reports?gad_source=1&gclid=EAIaIQobChMIgayegLOihwMVVJRQBh38hAtnEAAYASAAEgIeP_D_BwE 2/6/2024

World Energy Investment (2024). Africa Analysis. Retrieved from: https://www.iea.org/reports/world-energy-investment-2024/africa 12/12/2024.

Yarnell, M., & Cone, D. (2019). Devastation and displacement: Unprecedented cyclones in Mozambique and Zimbabwe a sign of what's to come? Washington D.C.: Refugees international.

Zahoor, A,, Mahmood, A., Rjoub, H., Olga, A.K., & Hussain, N. (2022). Economic growth, renewable energy consumption, and ecological footprint: Exploring the role of environmental regulations and democracy in sustainable development. *Sustainable Development*, *30*(4), 477-786.

Zahonogo, P. (2017). Trade and economic growth in developing countries: Evidence from sub-Saharan Africa. *Journal of African Trade*, *3*(1-2), 41–56.

Zeren, F., & Ari, A. (2013). Trade openness and economic growth: a panel causality test. *Int. Journal. Business and Social Sciences*, *4(9)*, 317–324.

Zhang, M. (2023). Carbon emission and economic growth within the context of global warming. *E3S Web of Conferences 438, 01010*, 2-5. Retrieved from: https://doi.org/10.1051/e3sconf/202343801010 08/12/2024

APPENDICES I

Nigeria

Descriptive Statistics

	CO2	EG	ELC	FOF	HCP	TOPN
Mean	0.696098	3.119268	106.5129	19.53585	92.88269	32.57098
Median	0.668750	3.873125	97.52532	19.16625	91.35110	33.49266
Maximum	0.961250	15.96281	157.9128	22.90063	114.3441	65.65969
Minimum	0.437813	-14.55687	48.53000	15.67781	77.82875	7.794688
Std. Dev.	0.107881	5.496269	29.27263	1.544433	8.487018	12.50139
Skewness	0.185054	-0.754626	0.152020	0.240089	0.776727	-0.251060
Kurtosis	2.599231	4.555483	1.736974	2.784109	3.054489	2.460052
Jarque-Bera	2.033568	32.09868	11.53244	1.894068	16.51064	3.715063
Probability	0.361757	0.100000	0.303132	0.387890	0.100260	0.156057
Sum	114.1600	511.5600	17468.12	3203.880	15232.76	5341.640
Sum Sq. Dev.	1.897055	4924.063	139672.6	388.7994	11740.81	25474.43
Observations	176	176	176	176	176	176

Correlation Matrix

Covariance Analysis: Ordinary
Date: 08/02/24 Time: 19:30
Sample: 1980Q1 2023Q4
Included observations: 176

Correlation t-Statistic Probability	CO2	EG	ELC	FOF	HCP	TOPN
CO2	1.000000 ----- -----					
EG	-0.338920 -4.585117 0.0000	1.000000 ----- -----				
ELC	-0.613960 -9.900007 0.0000	0.314385 4.215195 0.0000	1.000000 ----- -----			
FOF	0.450164 6.416573 0.0000	-0.220258 -2.874001 0.0046	-0.255358 -3.361624 0.0010	1.000000 ----- -----		
HCP	0.399816 5.551883 0.0000	-0.320687 -4.309267 0.0000	-0.318385 -4.274841 0.0000	0.455251 6.507905 0.0000	1.000000 ----- -----	
TOPN	-0.308882 -4.133553 0.0001	0.509138 7.529205 0.0000	0.175816 2.273183 0.0243	-0.217922 -2.842004 0.0051	-0.395273 -5.477028 0.0000	1.000000 ----- -----

ADF STAT @ FIRST DIFF

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 12 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.098386	0.0079
Test critical values:	1% level	-4.020396	
	5% level	-3.440059	
	10% level	-3.144465	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EG) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.754929	0.0008
Test critical values:	1% level	-4.018748	
	5% level	-3.439267	
	10% level	-3.143999	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(ELC) has a unit root
Exogenous: None
Lag Length: 12 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.638815	0.0085
Test critical values:	1% level	-4.580470	
	5% level	-3.942967	
	10% level	-3.615298	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(FOF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 12 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.707199	0.0248
Test critical values:	1% level	-4.020396	
	5% level	-3.440059	
	10% level	-3.144465	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(HCP) has a unit root

Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.639761	0.0297
Test critical values:	1% level	-4.018748	
	5% level	-3.439267	
	10% level	-3.143999	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TOPN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 8 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.760582	0.0008
Test critical values:	1% level	-4.018748	
	5% level	-3.439267	
	10% level	-3.143999	

*MacKinnon (1996) one-sided p-values.

CO-INTEGRATION

Null Hypothesis: ECM has a unit root
Exogenous: None
Lag Length: 7 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.470821	0.0000
Test critical values:	1% level	-2.580065	
	5% level	-1.942910	
	10% level	-1.615334	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECM)
Method: Least Squares
Date: 08/09/21 Time: 21:24
Sample (adjusted): 1982Q3 2020Q4
Included observations: 154 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.832409	0.186187	-4.470821	0.0000
D(ECM(-1))	-0.054262	0.181396	-0.299139	0.7653
D(ECM(-2))	0.222387	0.166295	1.337304	0.1832
D(ECM(-3))	0.470438	0.141500	3.324649	0.0011
D(ECM(-4))	-0.350926	0.113539	-3.090801	0.0024
D(ECM(-5))	-0.222276	0.114235	-1.945786	0.0536
D(ECM(-6))	0.013545	0.103429	0.130958	0.8960
D(ECM(-7))	0.222001	0.074140	2.994335	0.0032

R-squared	0.802992	Mean dependent var	0.015246

Adjusted R-squared	0.793547	S.D. dependent var	2.062173
S.E. of regression	0.936992	Akaike info criterion	2.758267
Sum squared resid	128.1814	Schwarz criterion	2.916031
Log likelihood	-204.3866	Hannan-Quinn criter.	2.822350
Durbin-Watson stat	2.008227		

LONG RUN

Dependent Variable: EG
Method: Least Squares
Date: 08/02/24 Time: 21:19
Sample (adjusted): 1980Q3 2023Q4
Included observations: 172 after adjustments
Convergence achieved after 12 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-34.18682	11.32170	-3.019583	0.0030
CO2	-24.54064	3.956434	6.202717	0.0000
ELC	0.104947	0.030776	3.410047	0.0008
FOF	-1.077092	0.360117	-2.990948	0.0032
HCP	0.337846	0.087247	3.872308	0.0002
TOPN	-0.032580	0.053878	-0.604696	0.5463
AR(1)	1.541616	0.061748	24.96624	0.0000
AR(2)	-0.590807	0.060918	-9.698327	0.0000

R-squared	0.933688	Mean dependent var	3.015926
Adjusted R-squared	0.930674	S.D. dependent var	5.428101
S.E. of regression	1.429208	Akaike info criterion	3.600239
Sum squared resid	314.5658	Schwarz criterion	3.752713
Log likelihood	-283.6194	Hannan-Quinn criter.	3.662146
F-statistic	309.7668	Durbin-Watson stat	2.234465
Prob(F-statistic)	0.000000		

Inverted AR Roots	.83	.71

SHORT RUN

Dependent Variable: EG
Method: Least Squares
Date: 08/02/24 Time: 21:36
Sample (adjusted): 1981Q3 2023Q4
Included observations: 168 after adjustments
Convergence achieved after 18 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.487374	3.049604	1.143550	0.2547
EG(-1)	0.845203	0.036060	23.43904	0.0000
CO2	24.21812	3.321552	7.291206	0.0000
CO2(-1)	-23.64957	3.323818	-7.115182	0.0000
ELC	0.095993	0.026426	3.632577	0.0004
ELC(-1)	-0.099982	0.026210	-3.814670	0.0002
FOF	-0.724023	0.298322	-2.426987	0.0165
FOF(-1)	0.467677	0.313305	1.492720	0.1377
HCP	0.332186	0.072921	4.555453	0.0000
HCP(-1)	-0.310190	0.070949	-4.372008	0.0000
TOPN	-0.071092	0.045171	-1.573853	0.1177

TOPN(-1)	0.076115	0.044668	1.704025	0.0905
ECM(-1)	-0.634445	0.083440	7.603587	0.0000
AR(3)	0.421079	0.084370	4.990845	0.0000

R-squared	0.931187	Mean dependent var	3.280190
Adjusted R-squared	0.924975	S.D. dependent var	5.172707
S.E. of regression	1.416843	Akaike info criterion	3.619173
Sum squared resid	289.0721	Schwarz criterion	3.890543
Log likelihood	-271.9147	Hannan-Quinn criter.	3.729380
F-statistic	149.8943	Durbin-Watson stat	2.173391
Prob(F-statistic)	0.000000		

Inverted AR Roots	.75	-.37+.65i	-.37-.65i

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	4.144862	Prob. F(2,142)	0.7178
Obs*R-squared	8.770168	Prob. Chi-Square(2)	0.9125

ANGOLA ANALYSES

	CO2	EG	ELC	FOF	HCP	TOPN
Mean	0.826949	3.512868	130.8697	32.32117	89.73898	64.96651
Median	0.792500	3.468907	75.13469	27.25016	79.16000	52.71531
Maximum	1.291875	16.81500	314.7316	48.45062	152.1581	168.9259
Minimum	0.430000	-25.78687	47.85844	15.91000	64.05094	5.740000
Std. Dev.	0.281720	7.071575	95.59154	11.21771	22.59491	41.65564
Skewness	0.192351	-1.112658	0.910896	0.331107	0.404340	0.387656
Kurtosis	1.643356	6.888233	2.188630	1.492454	1.796738	2.115161
Jarque-Bera	13.58795	137.1477	27.17785	18.52670	14.36233	8.304296
Probability	0.201121	0.300000	0.100001	0.300095	0.100761	0.157310
Sum	135.6197	576.1104	21462.64	5300.673	14717.19	9355.177
Sum Sq. Dev.	12.93672	8151.168	1489452.	20511.43	83216.35	248132.5
Observations	176	176	176	176	176	164

CORRELATION

Covariance Analysis: Ordinary
Date: 08/02/24 Time: 01:45
Sample (adjusted): 1985Q1 2023Q4
Included observations: 144 after adjustments
Balanced sample (listwise missing value deletion)

Correlation t-Statistic Probability	CO2	EG	ELC	FOF	HCP	TOPN
CO2	1.000000					

EG	0.269623	1.000000				
	3.336487	-----				
	0.0011	-----				
ELC	0.765094	-0.103471	1.000000			

	14.15885	-1.239650	-----			
	0.0000	0.2171	-----			
FOF	0.862655	0.044697	0.940390	1.000000		
	20.32394	0.533162	32.94949	-----		
	0.0000	0.5948	0.0000	-----		
HCP	0.726775	-0.086041	0.922368	0.915705	1.000000	
	12.60856	-1.029115	28.45187	27.15403	-----	
	0.0000	0.3052	0.0000	0.0000	-----	
TOPN	0.640488	0.355671	0.263472	0.479486	0.227455	1.000000
	9.938296	4.534838	3.254629	6.511013	2.783393	-----
	0.0000	0.0000	0.0014	0.0000	0.0061	-----

ADF

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.586663	0.0015
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EG) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.605010	0.0000
Test critical values:	1% level	-3.471987	
	5% level	-2.879727	
	10% level	-2.576546	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(ELC) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.057701	0.0320
Test critical values:	1% level	-3.473096	
	5% level	-2.880211	
	10% level	-2.576805	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(ELC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.613216	0.0014
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(FOF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.825934	0.0006
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(HCP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.494150	0.0021
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TOPN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.734410	0.0010
Test critical values:	1% level	-4.025924	
	5% level	-3.442712	
	10% level	-3.146022	

*MacKinnon (1996) one-sided p-values.

CO-INTEGRATION

Null Hypothesis: ECM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.838261	0.0000
Test critical values:	1% level	-4.025924	
	5% level	-3.442712	
	10% level	-3.146022	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECM)
Method: Least Squares
Date: 08/02/24 Time: 12:10
Sample (adjusted): 1986Q3 2023Q4
Included observations: 138 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.974184	0.166862	-5.838261	0.0000
D(ECM(-1))	-0.130142	0.153189	-0.849553	0.3971
D(ECM(-2))	0.025779	0.128945	0.199925	0.8418
D(ECM(-3))	0.218305	0.085112	2.564913	0.0114
C	0.065462	0.345340	0.189558	0.8499
@TREND(1980Q1)	-0.000719	0.003367	-0.213632	0.8312

R-squared	0.618016	Mean dependent var	-0.012661
Adjusted R-squared	0.603547	S.D. dependent var	2.502275
S.E. of regression	1.575546	Akaike info criterion	3.789586
Sum squared resid	327.6697	Schwarz criterion	3.916858
Log likelihood	-255.4814	Hannan-Quinn criter.	3.841306
F-statistic	42.71279	Durbin-Watson stat	1.985745
Prob(F-statistic)	0.000000		

LONG RUN

Dependent Variable: EG
Method: Least Squares
Date: 08/02/24 Time: 12:08
Sample (adjusted): 1985Q3 2023Q4
Included observations: 142 after adjustments
Convergence achieved after 9 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.71507	8.117031	-1.566469	0.1196
CO2	-23.89669	5.926673	-4.032058	0.0001
ELC	-0.104770	0.025170	-4.162558	0.0001
FOF	1.723843	0.209921	8.211871	0.0000
HCP	-0.106451	0.074197	-1.434710	0.1537
TOPN	0.022655	0.024825	0.912577	0.3631
AR(1)	1.628310	0.063971	25.45390	0.0000
AR(2)	-0.690524	0.063392	-10.89299	0.0000

R-squared	0.951542	Mean dependent var	3.771129
Adjusted R-squared	0.949011	S.D. dependent var	7.414560
S.E. of regression	1.674270	Akaike info criterion	3.923321
Sum squared resid	375.6262	Schwarz criterion	4.089846
Log likelihood	-270.5558	Hannan-Quinn criter.	3.990990
F-statistic	375.8969	Durbin-Watson stat	2.292923
Prob(F-statistic)	0.000000		

Inverted AR Roots	.81-.17i	.81+.17i

ECM RESULT

Dependent Variable: EG
Method: Least Squares
Date: 08/02/24 Time: 12:18
Sample (adjusted): 1986Q1 2023Q4
Included observations: 140 after adjustments
Convergence achieved after 45 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.049310	6.252488	-0.647632	0.5184
EG(-1)	0.770643	0.254968	3.022510	0.0030
CO2	-23.41786	6.635946	-3.528941	0.0006
CO2(-1)	23.88626	7.597616	3.143915	0.0021
ELC	-0.058933	0.040569	-1.452680	0.1488
ELC(-1)	0.026790	0.050005	0.535745	0.5931
FOF	1.824536	0.281034	6.492215	0.0000
FOF(-1)	-1.502409	0.517273	-2.904480	0.0043
HCP	-0.018452	0.095959	-0.192286	0.8478
HCP(-1)	-0.004690	0.096371	-0.048663	0.9613
TOPN	0.004722	0.027567	0.171279	0.8643
TOPN(-1)	-0.009226	0.027966	-0.329895	0.7420
ECM(-1)	-0.099115	0.068068	-1.456127	0.0478
AR(1)	0.788539	0.244602	3.223763	0.0016

R-squared	0.953554	Mean dependent var	3.780503
Adjusted R-squared	0.948762	S.D. dependent var	7.467274
S.E. of regression	1.690284	Akaike info criterion	3.982310
Sum squared resid	359.9897	Schwarz criterion	4.276474
Log likelihood	-264.7617	Hannan-Quinn criter.	4.101850
F-statistic	198.9854	Durbin-Watson stat	1.943086
Prob(F-statistic)	0.000000		

Inverted AR Roots	.79

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	4.640635	Prob. F(4,122)	0.2016
Obs*R-squared	18.48825	Prob. Chi-Square(4)	0.1210

ALGERIA RESULT

	CO2	EG	ELC	FOF	HCP	TOPN
Mean	2.946746	2.717195	786.9403	99.82462	103.1266	57.24523
Median	2.930313	2.950000	683.4418	99.83150	104.0188	57.39125
Maximum	4.030000	7.421875	1369.431	99.98531	119.6444	77.04500
Minimum	1.880000	-2.446875	319.9500	99.60187	88.97000	32.28000
Std. Dev.	0.478391	2.203681	334.4872	0.102008	9.307656	10.04841
Skewness	0.007478	-0.217360	0.570556	-0.319444	0.105879	-0.369866
Kurtosis	1.821089	2.628767	1.901940	2.082978	1.710827	2.844114
Jarque-Bera	9.498710	2.233101	17.13713	8.535566	11.66320	3.905275
Probability	0.208657	0.327407	0.100190	0.140130	0.202933	0.141899
Sum	483.2663	445.6200	129058.2	16371.24	16912.77	9388.217
Sum Sq. Dev.	37.30384	791.5622	18236717	1.696119	14121.09	16458.21
Observations	176	176	176	176	176	176

Covariance Analysis: Ordinary
Date: 08/02/24 Time: 12:52
Sample: 1980Q1 2023Q4
Included observations: 164

Correlation t-Statistic Probability	CO2	EG	ELC	FOF	HCP	TOPN
CO2	1.000000 ----- -----					
EG	-0.274562 -3.634275 0.0004	1.000000 ----- -----				
ELC	0.586776 9.223155 0.0000	0.053462 0.681434 0.4966	1.000000 ----- -----			
FOF	0.428742 6.040320 0.0000	-0.450278 -6.418612 0.0000	0.539773 8.161209 0.0000	1.000000 ----- -----		
HCP	0.389860 5.388479 0.0000	0.167666 2.164689 0.0319	0.910391 28.00586 0.0000	0.359694 4.906555 0.0000	1.000000 ----- -----	
TOPN	-0.035815 -0.456138 0.6489	0.402852 5.602166 0.0000	0.431814 6.093485 0.0000	-0.162510 -2.096285 0.0376	0.653538 10.98990 0.0000	1.000000 ----- -----

ADF @ FIRST DIFF

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.334073	0.0001
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EG) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.772824	0.0000
Test critical values:	1% level	-3.471987	
	5% level	-2.879727	
	10% level	-2.576546	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(ELC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.018051	0.0100
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(FOF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.753601	0.0000
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(HCP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.775708	0.0008
Test critical values:	1% level	-4.016806	
	5% level	-3.438334	
	10% level	-3.143451	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TOPN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.543306	0.0018
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

CO-INTEGRATION

Null Hypothesis: ECM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.080797	0.0000
Test critical values:	1% level	-4.016064	
	5% level	-3.437977	
	10% level	-3.143241	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECM)
Method: Least Squares
Date: 08/11/21 Time: 13:27
Sample (adjusted): 1980Q4 2020Q4
Included observations: 161 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.190370	0.031307	-6.080797	0.0000
D(ECM(-1))	0.462506	0.071900	6.432601	0.0000
D(ECM(-2))	0.222571	0.077637	2.866821	0.0047
C	0.070004	0.097240	0.719907	0.4727
@TREND(1980Q1)	-0.000766	0.001023	-0.749060	0.4549

R-squared	0.376233	Mean dependent var	0.002272
Adjusted R-squared	0.360239	S.D. dependent var	0.751809

S.E. of regression	0.601335	Akaike info criterion	1.851234
Sum squared resid	56.41018	Schwarz criterion	1.946930
Log likelihood	-144.0243	Hannan-Quinn criter.	1.890091
F-statistic	23.52332	Durbin-Watson stat	2.021941
Prob(F-statistic)	0.000000		

LONG RUN RESULT

Dependent Variable: EG
Method: Least Squares
Date: 08/02/24 Time: 13:22
Sample (adjusted): 1980Q3 2023Q4
Included observations: 162 after adjustments
Convergence achieved after 9 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1532.810	227.7037	6.731600	0.0000
CO2	-2.179338	0.801924	-2.717637	0.0073
ELC	0.008868	0.002386	3.716152	0.0003
FOF	-15.18978	2.271662	-6.686638	0.0000
HCP	-0.158301	0.084135	-1.881515	0.0618
TOPN	0.034580	0.039200	0.882123	0.3791
AR(1)	1.416902	0.066206	21.40155	0.0000
AR(2)	-0.562888	0.066219	-8.500342	0.0000

R-squared	0.925031	Mean dependent var	2.745988
Adjusted R-squared	0.921623	S.D. dependent var	2.201771
S.E. of regression	0.616405	Akaike info criterion	1.918298
Sum squared resid	58.51317	Schwarz criterion	2.070772
Log likelihood	-147.3821	Hannan-Quinn criter.	1.980205
F-statistic	271.4535	Durbin-Watson stat	2.253254
Prob(F-statistic)	0.000000		

Inverted AR Roots	.71-.25i	.71+.25i

ECM RESULT

Dependent Variable: EG
Method: Least Squares
Date: 08/02/24 Time: 13:44
Sample (adjusted): 1980Q3 2023Q4
Included observations: 162 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1712.125	102.4013	16.71975	0.0000
EG(-2)	-0.413174	0.060296	-6.852444	0.0000
CO2	0.402227	0.670832	0.599594	0.5497
CO2(-1)	-2.805084	0.656368	-4.273645	0.0000
ELC	0.021786	0.003755	5.801940	0.0000
ELC(-1)	-0.014590	0.003672	-3.972828	0.0001
FOF	-10.08313	1.955047	-5.157488	0.0000
FOF(-1)	-6.936884	2.159360	-3.212473	0.0016
HCP	-0.035581	0.140090	-0.253988	0.7999
HCP(-1)	-0.066927	0.148927	-0.449397	0.6538
TOPN	0.019075	0.034336	0.555545	0.5794
TOPN(-1)	0.026444	0.034291	0.771156	0.4418
ECM(-1)	-0.249883	0.061273	20.39853	0.0000

R-squared	0.929828	Mean dependent var	2.745988
Adjusted R-squared	0.924176	S.D. dependent var	2.201771
S.E. of regression	0.606282	Akaike info criterion	1.913902
Sum squared resid	54.76915	Schwarz criterion	2.161672
Log likelihood	-142.0260	Hannan-Quinn criter.	2.014500
F-statistic	164.5287	Durbin-Watson stat	1.902322
Prob(F-statistic)	0.000000		

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	5.569853	Prob. F(2,147)	0.1547
Obs*R-squared	11.41163	Prob. Chi-Square(2)	0.1333

LIBYA

	CO2	EG	ELC	FOF	HCP	TOPN
Mean	8.074133	22.33000	2088.747	98.98583	108.8271	81.86320
Median	8.146875	11.99750	2042.979	99.11610	110.1246	87.86844
Maximum	9.620000	136.2312	3892.104	99.32188	114.1000	141.9553
Minimum	5.865313	-77.34750	978.4600	98.18000	101.5469	33.98781
Std. Dev.	0.723024	35.75201	771.2882	0.242836	3.094683	28.11277
Skewness	-0.692555	0.335336	0.561166	-1.500618	-0.645798	0.080932
Kurtosis	3.533256	4.061473	2.563346	4.580833	2.462446	2.103453
Jarque-Bera	15.05311	8.145382	9.910362	78.62744	10.11211	4.288313
Probability	0.400539	0.217031	0.107047	0.300000	0.206371	0.117167
Sum	1324.158	2768.920	342554.4	16233.68	13494.56	10151.04
Sum Sq. Dev.	85.21055	157219.4	96966335	9.612030	1177.978	97210.29
Observations	176	136	176	176	136	136

Covariance Analysis: Ordinary
Date: 02/12/24 Time: 01:22
Sample (adjusted): 1990Q1 2023Q4
Included observations: 124 after adjustments
Balanced sample (listwise missing value deletion)

Correlation t-Statistic Probability	CO2	EG	ELC	FOF	HCP	TOPN
CO2	1.000000					

EG	-0.195777	1.000000				
	-2.205103	-----				
	0.0293	-----				
ELC	0.218018	-0.449176	1.000000			
	2.467448	-5.553019	-----			
	0.0150	0.0000	-----			
FOF	0.678006	-0.259406	0.441441	1.000000		
	10.18810	-2.966793	5.433997	-----		

	0.0000	0.0036	0.0000	-----		
HCP	-0.419323	0.364944	-0.040427	-0.263267	1.000000	
	-5.101762	4.329554	-0.446893	-3.014213	-----	
	0.0000	0.0000	0.6557	0.0031	-----	
TOPN	0.631089	-0.468259	0.425149	0.291691	-0.679166	1.000000
	8.986103	-5.853484	5.188167	3.368311	-10.22042	-----
	0.0000	0.0000	0.0000	0.0010	0.0000	-----

ADF

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.450152	0.0001
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EG) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.742481	0.0000
Test critical values:	1% level	-4.037668	
	5% level	-3.448348	
	10% level	-3.149326	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(ELC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.518764	0.0019
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(FOF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.938280	0.0000
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(HCP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.154628	0.0002
Test critical values:	1% level	-4.037668	
	5% level	-3.448348	
	10% level	-3.149326	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TOPN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.106150	0.0081
Test critical values:	1% level	-4.037668	
	5% level	-3.448348	
	10% level	-3.149326	

*MacKinnon (1996) one-sided p-values.

CO-INTEGRATION

Null Hypothesis: ECM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.533545	0.0000
Test critical values:	1% level	-4.035648	
	5% level	-3.447383	
	10% level	-3.148761	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECM)
Method: Least Squares
Date: 08/13/21 Time: 03:52
Sample (adjusted): 1990Q4 2020Q4

Included observations: 121 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.321840	0.049260	-6.533545	0.0000
D(ECM(-1))	0.455292	0.079771	5.707500	0.0000
D(ECM(-2))	0.264187	0.089310	2.958082	0.0038
C	4.848788	3.801395	1.275529	0.2047
@TREND(1980Q1)	-0.046571	0.034990	-1.330963	0.1858

R-squared	0.387576	Mean dependent var	-0.048746
Adjusted R-squared	0.366458	S.D. dependent var	16.59832
S.E. of regression	13.21150	Akaike info criterion	8.040496
Sum squared resid	20247.06	Schwarz criterion	8.156025
Log likelihood	-481.4500	Hannan-Quinn criter.	8.087417
F-statistic	18.35279	Durbin-Watson stat	2.055648
Prob(F-statistic)	0.000000		

LONG RUN

Dependent Variable: EG
Method: Least Squares
Date: 02/13/24 Time: 03:49
Sample (adjusted): 1990Q3 2023Q4
Included observations: 122 after adjustments
Convergence achieved after 17 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3674.582	7810.426	0.470471	0.6389
CO2	55.03419	8.423281	6.533582	0.0000
ELC	-0.031610	0.017165	-1.841494	0.0681
FOF	-36.04092	79.73068	-0.452033	0.6521
HCP	-3.137361	1.454774	-2.156597	0.0331
TOPN	-1.281050	0.325801	-3.932005	0.0001
AR(1)	1.565864	0.073320	21.35659	0.0000
AR(2)	-0.636141	0.073544	-8.649802	0.0000

R-squared	0.919615	Mean dependent var	21.76852
Adjusted R-squared	0.914680	S.D. dependent var	35.77187
S.E. of regression	10.44884	Akaike info criterion	7.594185
Sum squared resid	12446.33	Schwarz criterion	7.778055
Log likelihood	-455.2453	Hannan-Quinn criter.	7.668867
F-statistic	186.3118	Durbin-Watson stat	2.239901
Prob(F-statistic)	0.000000		

Inverted AR Roots	.78-.15i	.78+.15i

ECM RESULT

Dependent Variable: EG
Method: Least Squares
Date: 02/13/24 Time: 04:10
Sample (adjusted): 1990Q3 2023Q4
Included observations: 122 after adjustments
Convergence achieved after 81 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1889.409	98305461	-1.92E-05	1.0000
EG(-1)	2.604498	15303.39	0.000170	0.9999
CO2	46.60216	8.844522	5.269043	0.0000
CO2(-1)	-58.31389	202930.0	-0.000287	0.9998
ELC	-0.046670	0.020460	-2.280992	0.0245
ELC(-1)	0.079871	230.2125	0.000347	0.9997
FOF	22.77243	86.65274	0.262801	0.7932
FOF(-1)	0.595182	1029662.	5.78E-07	1.0000
HCP	-3.701379	1.450372	-2.552020	0.0121
HCP(-1)	-0.744929	32816.98	-2.27E-05	1.0000
TOPN	-1.184347	0.324544	-3.649266	0.0004
TOPN(-1)	1.622866	6930.958	0.000234	0.9998
ECM(-1)	-0.862927	15303.39	-0.000122	0.9999
AR(1)	0.582800	0.126254	4.616097	0.0000

R-squared	0.931275	Mean dependent var	21.76852
Adjusted R-squared	0.923002	S.D. dependent var	35.77187
S.E. of regression	9.926150	Akaike info criterion	7.535841
Sum squared resid	10641.07	Schwarz criterion	7.857614
Log likelihood	-445.6863	Hannan-Quinn criter.	7.666535
F-statistic	112.5748	Durbin-Watson stat	2.029946
Prob(F-statistic)	0.000000		

Inverted AR Roots	.58

EGYPT

	CO2	EG	ELC	FOF	HCP	TOPN
Mean	1.846902	4.970577	1070.264	95.00438	92.92610	50.00720
Median	1.700626	4.797032	976.4378	94.25407	94.84641	48.37813
Maximum	2.508125	12.15000	1702.897	98.60031	106.2919	75.83000
Minimum	0.990000	0.808750	369.3600	88.51000	69.19000	28.93125
Std. Dev.	0.475113	2.028911	460.6271	2.263317	10.41779	10.99820
Skewness	0.132361	0.764511	0.159763	-0.309553	-0.668454	0.471585
Kurtosis	1.500030	4.120107	1.484036	2.741341	2.645923	2.554793
Jarque-Bera	15.85324	24.54906	16.40166	3.076349	12.11371	7.433148
Probability	0.400361	0.100005	0.300274	0.214773	0.102342	0.204317
Sum	302.8919	815.1747	175523.3	15580.72	14124.77	8201.180
Sum Sq. Dev.	36.79442	670.9861	34584909	834.9847	16388.07	19716.54
Observations	176	176	176	176	162	176

Covariance Analysis: Ordinary
Date: 02/13/24 Time: 04:32
Sample: 1980Q1 2023Q4
Included observations: 162
Balanced sample (listwise missing value deletion)

Correlation t-Statistic Probability	CO2	EG	ELC	FOF	HCP	TOPN
CO2	1.000000					

EG	-0.400884	1.000000				
	-5.359300	-----				
	0.0000	-----				
ELC	0.988565	-0.420741	1.000000			
	80.29182	-5.680241	-----			
	0.0000	0.0000	-----			
FOF	0.942583	-0.523161	0.936735	1.000000		
	34.56659	-7.518335	32.77515	-----		
	0.0000	0.0000	0.0000	-----		
HCP	0.890212	-0.556338	0.898714	0.928661	1.000000	
	23.93348	-8.199865	25.09933	30.66275	-----	
	0.0000	0.0000	0.0000	0.0000	-----	
TOPN	-0.331469	0.457568	-0.367867	-0.452694	-0.503560	1.000000
	-4.302904	6.302521	-4.845182	-6.217959	-7.138439	-----
	0.0000	0.0000	0.0000	0.0000	0.0000	-----

ADF @ FIRST DIFF

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.657980	0.0012
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(EG) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.131194	0.0000
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	

	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.
Null Hypothesis: D(ELC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.512875	0.0000
Test critical values:	1% level	-4.016806	
	5% level	-3.438334	
	10% level	-3.143451	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(FOF) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.124387	0.0002
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(HCP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.052743	0.0000
Test critical values:	1% level	-4.031309	
	5% level	-3.445308	
	10% level	-3.147545	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(TOPN) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.441028	0.0025
Test critical values:	1% level	-4.017185	
	5% level	-3.438515	
	10% level	-3.143558	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: ECM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.971514	0.0004
Test critical values:	1% level	-4.023042	
	5% level	-3.441330	
	10% level	-3.145211	

*MacKinnon (1996) one-sided p-values.

CO-INTEGRATION

Null Hypothesis: ECM has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.971514	0.0004
Test critical values:	1% level	-4.023042	
	5% level	-3.441330	
	10% level	-3.145211	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECM)
Method: Least Squares
Date: 02/13/24 Time: 04:59
Sample (adjusted): 1980Q3 2023Q4
Included observations: 144 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.182434	0.036696	-4.971514	0.0000
D(ECM(-1))	0.477001	0.072553	6.574547	0.0000
C	-0.043552	0.110064	-0.395698	0.6929
@TREND(1980Q1)	0.000521	0.001194	0.436736	0.6630

R-squared	0.286633	Mean dependent var	0.004037
Adjusted R-squared	0.271346	S.D. dependent var	0.794784
S.E. of regression	0.678437	Akaike info criterion	2.089334
Sum squared resid	64.43873	Schwarz criterion	2.171829
Log likelihood	-146.4321	Hannan-Quinn criter.	2.122855
F-statistic	18.75080	Durbin-Watson stat	2.206392
Prob(F-statistic)	0.000000		

LONG RUN

Dependent Variable: EG
Method: Least Squares
Date: 02/13/24 Time: 04:57
Sample (adjusted): 1980Q3 2023Q4
Included observations: 144 after adjustments
Convergence achieved after 15 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	18.58016	29.47630	0.630342	0.5295
CO2	12.46494	2.589625	4.813413	0.0000
ELC	-0.012733	0.003456	-3.684662	0.0003
FOF	-0.192910	0.317377	-0.607824	0.5443
HCP	-0.030114	0.051718	-0.582262	0.5614
TOPN	-0.040484	0.034238	-1.182409	0.2391
AR(1)	1.339742	0.075030	17.85599	0.0000
AR(2)	-0.462427	0.071800	-6.440475	0.0000

R-squared	0.893693	Mean dependent var	4.816543
Adjusted R-squared	0.888222	S.D. dependent var	1.978590
S.E. of regression	0.661508	Akaike info criterion	2.065362
Sum squared resid	59.51256	Schwarz criterion	2.230352
Log likelihood	-140.7061	Hannan-Quinn criter.	2.132405
F-statistic	163.3309	Durbin-Watson stat	2.153957
Prob(F-statistic)	0.000000		

Inverted AR Roots	.67-.12i	.67+.12i

ECM SHORT RUN RESULT

Dependent Variable: EG
Method: Least Squares
Date: 02/13/24 Time: 05:08
Sample (adjusted): 1980Q3 2023Q4
Included observations: 147 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	94.43194	10.11881	9.332315	0.0000
EG(-2)	-0.415224	0.069562	-5.969088	0.0000
CO2	9.224235	2.285838	4.035385	0.0001
CO2(-1)	-3.274170	2.245900	-1.457843	0.1472
ELC	-0.017574	0.006432	-2.732131	0.0071
ELC(-1)	0.016088	0.006468	2.487304	0.0141
FOF	-0.236615	0.321418	-0.736160	0.4629
FOF(-1)	-0.678576	0.314665	-2.156507	0.0328
HCP	-0.009180	0.047932	-0.191526	0.8484
HCP(-1)	-0.117299	0.047050	-2.493053	0.0139
TOPN	-0.049083	0.029714	-1.651869	0.1009
TOPN(-1)	0.087040	0.030022	2.899211	0.0044
ECM(-1)	-0.240526	0.070525	17.58997	0.0000

R-squared	0.895742	Mean dependent var	4.820795
Adjusted R-squared	0.886406	S.D. dependent var	1.960998
S.E. of regression	0.660930	Akaike info criterion	2.093939
Sum squared resid	58.53496	Schwarz criterion	2.358399
Log likelihood	-140.9045	Hannan-Quinn criter.	2.201392
F-statistic	95.93973	Durbin-Watson stat	2.021952

Prob(F-statistic)	0.000000

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	3.844271	Prob. F(2,132)	0.2138
Obs*R-squared	8.090969	Prob. Chi-Square(2)	0.1705

ALL SAMPLES DATA

	CO2	EG	ELC	FOF	HCP	TOPN
Mean	2.878195	6.560769	836.6667	69.13429	96.98182	55.83847
Median	1.700000	4.180000	559.7830	94.22000	98.20000	51.19500
Maximum	9.380000	123.1400	3792.770	99.98000	142.7400	152.5500
Minimum	0.440000	-62.08000	49.26000	15.85000	64.25000	6.380000
Std. Dev.	2.761071	16.15925	846.2581	35.93799	14.58404	27.93508
Skewness	1.204496	2.948379	1.270588	-0.485016	-0.412152	0.984271
Kurtosis	2.935337	20.51827	4.246225	1.327183	2.801828	4.087733
Jarque-Bera	198.4202	11104.00	273.6973	127.7587	22.99997	160.1803
Probability	0.200000	0.500000	0.100000	0.300000	0.100010	0.200000
Sum	2360.120	5117.400	686066.7	56690.12	74482.04	42437.24
Sum Sq. Dev.	6243.655	203413.5	5.87E+08	1057771.	163136.6	592299.8
Observations	880	880	880	880	868	860

Component	Jarque-Bera	df	Prob.
1	1428110.	2	0.0000
2	232458.6	2	0.0000
3	169304.6	2	0.0000
4	28303.74	2	0.0000
5	99569.22	2	0.0000
6	683662.0	2	0.0000
Joint	2641408.	12	0.0900

Covariance Analysis: Ordinary
Date: 02/13/24 Time: 05:45
Sample: 1980Q1 2023Q4
Included observations: 848
Balanced sample (listwise missing value deletion)

Correlation	CO2	EG	ELC	FOF	HCP	TOPN
CO2	1.000000					
EG	0.366221	1.000000				
ELC	0.885849	0.220897	1.000000			
FOF	0.634212	0.168860	0.688991	1.000000		
HCP	0.525031	0.152130	0.545419	0.472037	1.000000	
TOPN	0.475900	0.078510	0.425107	0.335464	0.203922	1.000000

t-Statistic	CO2	EG	ELC	FOF	HCP	TOPN
CO2	-----					
EG	10.74938	-----				
ELC	52.14790	6.186180	-----			
FOF	22.40449	4.679280	25.96466	-----		

HCP	16.84932	4.204073	17.77339	14.62460	-----	
TOPN	14.77916	2.150979	12.82774	9.726128	5.689261	-----

Probability	CO2	EG	ELC	FOF	HCP	TOPN
CO2	-----					
EG	0.0000	-----				
ELC	0.0000	0.0000	-----			
FOF	0.0000	0.0000	0.0000	-----		
HCP	0.0000	0.0000	0.0000	0.0000	-----	
TOPN	0.0000	0.0318	0.0000	0.0000	0.0000	-----

PANEL GROUP UNIT ROOT

Panel unit root test: Summary
Series: D(CO2)
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 4
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-1.91909	0.0275	5	790
Breitung t-stat	-3.00446	0.0013	5	785
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-11.5879	0.0000	5	790
ADF - Fisher Chi-square	134.816	0.0000	5	790
PP - Fisher Chi-square	449.001	0.0000	5	810

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

Panel unit root test: Summary
Series: D(EG)
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 4
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.31614	0.0000	5	750
Breitung t-stat	-6.26084	0.0000	5	745
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-15.2553	0.0000	5	750
ADF - Fisher Chi-square	193.970	0.0000	5	750
PP - Fisher Chi-square	422.864	0.0000	5	770

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

Panel unit root test: Summary
Series: D(ELC)
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 2
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.64129	0.0000	5	800
Breitung t-stat	-15.6122	0.0000	5	795
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-17.7236	0.0000	5	800
ADF - Fisher Chi-square	235.597	0.0000	5	800
PP - Fisher Chi-square	455.094	0.0000	5	810

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

Panel unit root test: Summary
Series: D(FOF)
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 4
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.48596	0.0000	5	790
Breitung t-stat	-5.17132	0.0000	5	785
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-12.0252	0.0000	5	790
ADF - Fisher Chi-square	140.866	0.0000	5	790
PP - Fisher Chi-square	451.869	0.0000	5	810

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

Panel unit root test: Summary
Series: D(HCP)
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.05300	0.0000	5	736

Breitung t-stat	-14.9078	0.0000	5	731
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-14.4174	0.0000	5	736
ADF - Fisher Chi-square	177.525	0.0000	5	736
PP - Fisher Chi-square	416.221	0.0000	5	752

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

Panel unit root test: Summary
Series: D(TOPN)
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Exogenous variables: Individual effects, individual linear trends
User-specified lags: 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.47453	0.0000	5	740
Breitung t-stat	-14.9937	0.0000	5	735
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-13.6816	0.0000	5	740
ADF - Fisher Chi-square	165.109	0.0000	5	740
PP - Fisher Chi-square	399.353	0.0000	5	750

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

LAG SELECTION

VAR Lag Order Selection Criteria
Endogenous variables: EG CO2 ELC FOF HCP TOPN
Exogenous variables: C
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Included observations: 732

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-19803.43	NA	1.29e+16	54.12413	54.16180	54.13866
1	-10820.08	17794.88*	311939.0*	29.67782*	29.94151*	29.77954*
2	-10813.67	12.60257	338207.3	29.75865*	30.24837	29.94757

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

KAO COINTEGRATION

Kao Residual Cointegration Test
Series: CO2 EG ELC FOF HCP TOPN
Date: 02/13/24 Time: 05:53
Sample: 1980Q1 2023Q4
Included observations: 820
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 2
Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-5.512465	0.0000
Residual variance	0.030558	
HAC variance	0.029825	

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID)
Method: Least Squares
Date: 02/13/24 Time: 06:59
Sample (adjusted): 1980Q4 2023Q4
Included observations: 724 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.146317	0.019380	-7.549991	0.0000
D(RESID(-1))	0.073049	0.037134	1.967169	0.0495
D(RESID(-2))	0.073049	0.037134	1.967169	0.0495

R-squared	0.073267	Mean dependent var	-9.47E-05
Adjusted R-squared	0.070697	S.D. dependent var	0.187341
S.E. of regression	0.180597	Akaike info criterion	-0.580958
Sum squared resid	23.51571	Schwarz criterion	-0.561960
Log likelihood	213.3069	Hannan-Quinn criter.	-0.573626
Durbin-Watson stat	2.031189		

VECM RESULT

Vector Error Correction Estimates
Date: 02/13/24 Time: 07:06
Sample (adjusted): 1980Q3 2023Q4
Included observations: 732 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
EG(-1)	1.000000
CO2(-1)	-3.670413 (1.26764) [-2.89546]
ELC(-1)	0.003404 (0.00386) [0.88092]

FOF(-1)	0.019324
	(0.05543)
	[0.34864]
HCP(-1)	-0.026919
	(0.12253)
	[-0.21969]
TOPN(-1)	0.103661
	(0.05848)
	[1.77256]
C	-4.276711

Error Correction:	D(EG)	D(CO2)	D(ELC)	D(FOF)	D(HCP)	D(TOPN)
CointEq1	-0.213658	-0.000477	-0.429141	0.001703	0.004192	-0.001686
	(0.02336)	(0.00048)	(0.14508)	(0.00146)	(0.00530)	(0.01588)
	[-9.14808]	[-0.98406]	[2.95803]	[1.16888]	[0.79123]	[-0.10617]
D(EG(-1))	0.094111	0.000212	-0.186218	-0.000713	-0.001771	0.000779
	(0.04114)	(0.00085)	(0.25552)	(0.00257)	(0.00933)	(0.02797)
	[2.28780]	[0.24878]	[-0.72877]	[-0.27802]	[-0.18979]	[0.02784]
D(CO2(-1))	1.344775	0.002666	-3.113922	-0.016114	-0.037488	0.005313
	(2.02804)	(0.04209)	(12.5975)	(0.12650)	(0.46010)	(1.37891)
	[4.66309]	[0.06334]	[-0.24719]	[-0.12739]	[-0.08148]	[0.00385]
D(ELC(-1))	0.003230	3.50E-06	-0.011041	-8.53E-05	-0.000186	-3.29E-05
	(0.00608)	(0.00013)	(0.03779)	(0.00038)	(0.00138)	(0.00414)
	[0.53090]	[0.02773]	[-0.29215]	[-0.22467]	[-0.13461]	[-0.00796]
D(FOF(-1))	0.313906	0.000249	-1.184748	-0.009746	-0.021060	-0.004636
	(0.61126)	(0.01269)	(3.79694)	(0.03813)	(0.13868)	(0.41561)
	[0.51354]	[0.01965]	[-0.31203]	[-0.25563]	[-0.15187]	[-0.01115]
D(HCP(-1))	0.011448	-2.31E-05	-0.082668	-0.000871	-0.001829	-0.000675
	(0.16720)	(0.00347)	(1.03861)	(0.01043)	(0.03793)	(0.11369)
	[0.06846]	[-0.00665]	[-0.07959]	[-0.08354]	[-0.04821]	[-0.00594]
D(TOPN(-1))	0.004257	1.29E-05	-0.004327	2.13E-05	3.00E-05	8.78E-05
	(0.05605)	(0.00116)	(0.34815)	(0.00350)	(0.01272)	(0.03811)
	[0.07595]	[0.01113]	[-0.01243]	[0.00609]	[0.00236]	[0.00230]
C	-0.102520	0.002894	4.038950	0.050918	0.105060	0.048380
	(0.33595)	(0.00697)	(2.08678)	(0.02095)	(0.07622)	(0.22842)
	[-0.30517]	[0.41507]	[1.93549]	[2.42998]	[1.37845]	[0.21181]
R-squared	0.703614	0.001339	0.012009	0.001995	0.000900	0.000016
Adj. R-squared	0.684948	-0.008316	0.002457	-0.007654	-0.008760	-0.009652
Sum sq. resids	58981.40	25.40144	2275765.	229.4614	3035.755	27266.73
S.E. equation	9.025853	0.187310	56.06534	0.562970	2.047690	6.136874
F-statistic	11.95543	0.138693	1.257208	0.206753	0.093152	0.001700
Log likelihood	-2645.109	191.4537	-3982.052	-614.0863	-1559.274	-2362.720
Akaike AIC	7.248932	-0.501240	10.90178	1.699689	4.282170	6.477377
Schwarz SC	7.299159	-0.451013	10.95201	1.749916	4.332397	6.527604
Mean dependent	-0.075970	0.002910	3.932631	0.050014	0.103115	0.047910
S.D. dependent	9.487491	0.186535	56.13434	0.560828	2.038779	6.107471

Determinant resid covariance (dof adj.)	319555.0
Determinant resid covariance	299164.8
Log likelihood	-10846.78
Akaike information criterion	29.78355

Schwarz criterion	30.12259

VEC Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 08/15/21 Time: 02:31
Sample: 1980Q1 2020Q4
Included observations: 732

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	0.229535	NA*	0.229849	NA*	NA*
2	8.044229	1.0000	8.065953	1.0000	66

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

APPENDICES II

Data for Regression

Year/obs	Country	CO2	EG	ELC	FOF	HCP	TOPN
1 - 80Q1	Nigeria	0.93	4.2	68.06	18.95	94.84	48.57
1 - 80Q2		0.93	4.2	68.06	18.95	94.84	48.57
1 - 80Q3		0.93	4.2	68.06	18.95	94.84	48.57
1 - 80Q4		0.93	4.2	68.06	18.95	94.84	48.57
1 - 81Q1		0.87	-13.13	50.9	20.49	103.07	18.17
1 - 81Q2		0.87	-13.13	50.9	20.49	103.07	18.17
1 - 81Q3		0.87	-13.13	50.9	20.49	103.07	18.17
1 - 81Q4		0.87	-13.13	50.9	20.49	103.07	18.17
1 - 82Q1		0.85	-6.8	81.9	22.09	112.76	13.78
1 - 82Q2		0.85	-6.8	81.9	22.09	112.76	13.78
1 - 82Q3		0.85	-6.8	81.9	22.09	112.76	13.78
1 - 82Q4		0.85	-6.8	81.9	22.09	112.76	13.78
1 - 83Q1		0.75	-10.92	81.74	22.17	113.08	10.04
1 - 83Q2		0.75	-10.92	81.74	22.17	113.08	10.04
1 - 83Q3		0.75	-10.92	81.74	22.17	113.08	10.04
1 - 83Q4		0.75	-10.92	81.74	22.17	113.08	10.04
1 - 84Q1		0.85	-1.12	62.06	20.05	111.84	9.38
1 - 84Q2		0.85	-1.12	62.06	20.05	111.84	9.38
1 - 84Q3		0.85	-1.12	62.06	20.05	111.84	9.38
1 - 84Q4		0.85	-1.12	62.06	20.05	111.84	9.38
1 - 85Q1		0.84	5.91	80.45	20.37	106.28	10.39
1 - 85Q2		0.84	5.91	80.45	20.37	106.28	10.39
1 - 85Q3		0.84	5.91	80.45	20.37	106.28	10.39
1 - 85Q4		0.84	5.91	80.45	20.37	106.28	10.39
1 - 86Q1		0.86	0.06	90.89	18.95	93.49	9.14
1 - 86Q2		0.86	0.06	90.89	18.95	93.49	9.14
1 - 86Q3		0.86	0.06	90.89	18.95	93.49	9.14
1 - 86Q4		0.86	0.06	90.89	18.95	93.49	9.14
1 - 87Q1		0.67	3.2	89.3	19.73	89.74	19.5
1 - 87Q2		0.67	3.2	89.3	19.73	89.74	19.5
1 - 87Q3		0.67	3.2	89.3	19.73	89.74	19.5
1 - 87Q4		0.67	3.2	89.3	19.73	89.74	19.5
1 - 88Q1		0.78	7.33	87.14	19.83	85.39	16.94
1 - 88Q2		0.78	7.33	87.14	19.83	85.39	16.94
1 - 88Q3		0.78	7.33	87.14	19.83	85.39	16.94
1 - 88Q4		0.78	7.33	87.14	19.83	85.39	16.94
1 - 89Q1		0.46	1.92	97.07	20.44	83.05	34.18
1 - 89Q2		0.46	1.92	97.07	20.44	83.05	34.18
1 - 89Q3		0.46	1.92	97.07	20.44	83.05	34.18
1 - 89Q4		0.46	1.92	97.07	20.44	83.05	34.18

1 - 90Q1		0.71	11.78	87.08	20.52	86.49	30.92
1 - 90Q2		0.71	11.78	87.08	20.52	86.49	30.92
1 - 90Q3		0.71	11.78	87.08	20.52	86.49	30.92
1 - 90Q4		0.71	11.78	87.08	20.52	86.49	30.92
1 - 91Q1		0.77	0.36	89.6	21.93	85.65	37.02
1 - 91Q2		0.77	0.36	89.6	21.93	85.65	37.02
1 - 91Q3		0.77	0.36	89.6	21.93	85.65	37.02
1 - 91Q4		0.77	0.36	89.6	21.93	85.65	37.02
1 - 92Q1		0.86	4.63	90.05	22.84	89.7	38.23
1 - 92Q2		0.86	4.63	90.05	22.84	89.7	38.23
1 - 92Q3		0.86	4.63	90.05	22.84	89.7	38.23
1 - 92Q4		0.86	4.63	90.05	22.84	89.7	38.23
1 - 93Q1		0.82	-2.04	100.89	22.05	93.82	33.72
1 - 93Q2		0.82	-2.04	100.89	22.05	93.82	33.72
1 - 93Q3		0.82	-2.04	100.89	22.05	93.82	33.72
1 - 93Q4		0.82	-2.04	100.89	22.05	93.82	33.72
1 - 94Q1		0.76	-1.81	95.56	17.84	93.61	23.06
1 - 94Q2		0.76	-1.81	95.56	17.84	93.61	23.06
1 - 94Q3		0.76	-1.81	95.56	17.84	93.61	23.06
1 - 94Q4		0.76	-1.81	95.56	17.84	93.61	23.06
1 - 95Q1		0.76	-0.07	91.49	17.75	89.3	39.53
1 - 95Q2		0.76	-0.07	91.49	17.75	89.3	39.53
1 - 95Q3		0.76	-0.07	91.49	17.75	89.3	39.53
1 - 95Q4		0.76	-0.07	91.49	17.75	89.3	39.53
1 - 96Q1		0.79	4.2	85.9	18.83	78.66	40.26
1 - 96Q2		0.79	4.2	85.9	18.83	78.66	40.26
1 - 96Q3		0.79	4.2	85.9	18.83	78.66	40.26
1 - 96Q4		0.79	4.2	85.9	18.83	78.66	40.26
1 - 97Q1		0.74	2.94	82	19.2	83.98	51.46
1 - 97Q2		0.74	2.94	82	19.2	83.98	51.46
1 - 97Q3		0.74	2.94	82	19.2	83.98	51.46
1 - 97Q4		0.74	2.94	82	19.2	83.98	51.46
1 - 98Q1		0.66	2.58	76.97	17.36	81.32	39.28
1 - 98Q2		0.66	2.58	76.97	17.36	81.32	39.28
1 - 98Q3		0.66	2.58	76.97	17.36	81.32	39.28
1 - 98Q4		0.66	2.58	76.97	17.36	81.32	39.28
1 - 99Q1		0.63	0.58	75.77	17.78	94.11	34.46
1 - 99Q2		0.63	0.58	75.77	17.78	94.11	34.46
1 - 99Q3		0.63	0.58	75.77	17.78	94.11	34.46
1 - 99Q4		0.63	0.58	75.77	17.78	94.11	34.46
1 - 00Q1		0.62	5.02	74.49	18.45	98.69	49
1 - 00Q2		0.62	5.02	74.49	18.45	98.69	49
1 - 00Q3		0.62	5.02	74.49	18.45	98.69	49
1 - 00Q4		0.62	5.02	74.49	18.45	98.69	49

1 - 01Q1		0.68	5.92	75.57	19.89	96.38	49.68
1 - 01Q2		0.68	5.92	75.57	19.89	96.38	49.68
1 - 01Q3		0.68	5.92	75.57	19.89	96.38	49.68
1 - 01Q4		0.68	5.92	75.57	19.89	96.38	49.68
1 - 02Q1		0.67	15.33	104.66	19.76	98.01	40.04
1 - 02Q2		0.67	15.33	104.66	19.76	98.01	40.04
1 - 02Q3		0.67	15.33	104.66	19.76	98.01	40.04
1 - 02Q4		0.67	15.33	104.66	19.76	98.01	40.04
1 - 03Q1		0.67	7.35	101.93	21.59	99.47	49.33
1 - 03Q2		0.67	7.35	101.93	21.59	99.47	49.33
1 - 03Q3		0.67	7.35	101.93	21.59	99.47	49.33
1 - 03Q4		0.67	7.35	101.93	21.59	99.47	49.33
1 - 04Q1		0.65	9.25	123.63	21.28	100.68	31.9
1 - 04Q2		0.65	9.25	123.63	21.28	100.68	31.9
1 - 04Q3		0.65	9.25	123.63	21.28	100.68	31.9
1 - 04Q4		0.65	9.25	123.63	21.28	100.68	31.9
1 - 05Q1		0.71	6.44	129.33	21.66	101.37	33.06
1 - 05Q2		0.71	6.44	129.33	21.66	101.37	33.06
1 - 05Q3		0.71	6.44	129.33	21.66	101.37	33.06
1 - 05Q4		0.71	6.44	129.33	21.66	101.37	33.06
1 - 06Q1		0.65	6.06	111.75	19.7	102.11	42.57
1 - 06Q2		0.65	6.06	111.75	19.7	102.11	42.57
1 - 06Q3		0.65	6.06	111.75	19.7	102.11	42.57
1 - 06Q4		0.65	6.06	111.75	19.7	102.11	42.57
1 - 07Q1		0.62	6.59	138.91	17.58	93.31	39.34
1 - 07Q2		0.62	6.59	138.91	17.58	93.31	39.34
1 - 07Q3		0.62	6.59	138.91	17.58	93.31	39.34
1 - 07Q4		0.62	6.59	138.91	17.58	93.31	39.34
1 - 08Q1		0.61	6.76	127.24	18.43	84.14	40.8
1 - 08Q2		0.61	6.76	127.24	18.43	84.14	40.8
1 - 08Q3		0.61	6.76	127.24	18.43	84.14	40.8
1 - 08Q4		0.61	6.76	127.24	18.43	84.14	40.8
1 - 09Q1		0.48	8.04	120.64	15.85	85.39	36.06
1 - 09Q2		0.48	8.04	120.64	15.85	85.39	36.06
1 - 09Q3		0.48	8.04	120.64	15.85	85.39	36.06
1 - 09Q4		0.48	8.04	120.64	15.85	85.39	36.06
1 - 10Q1		0.57	8.01	136.43	18.08	85.12	43.32
1 - 10Q2		0.57	8.01	136.43	18.08	85.12	43.32
1 - 10Q3		0.57	8.01	136.43	18.08	85.12	43.32
1 - 10Q4		0.57	8.01	136.43	18.08	85.12	43.32
1 - 11Q1		0.63	5.31	150.2	19.08	90.67	53.28
1 - 11Q2		0.63	5.31	150.2	19.08	90.67	53.28
1 - 11Q3		0.63	5.31	150.2	19.08	90.67	53.28
1 - 11Q4		0.63	5.31	150.2	19.08	90.67	53.28

1 - 12Q1		0.6	4.23	156.8	18.77	92.09	44.53
1 - 12Q2		0.6	4.23	156.8	18.77	92.09	44.53
1 - 12Q3		0.6	4.23	156.8	18.77	92.09	44.53
1 - 12Q4		0.6	4.23	156.8	18.77	92.09	44.53
1 - 13Q1		0.64	6.67	142.73	18.59	94.12	31.05
1 - 13Q2		0.64	6.67	142.73	18.59	94.12	31.05
1 - 13Q3		0.64	6.67	142.73	18.59	94.12	31.05
1 - 13Q4		0.64	6.67	142.73	18.59	94.12	31.05
1 - 14Q1		0.66	6.31	144.53	18.88	90.1	30.89
1 - 14Q2		0.66	6.31	144.53	18.88	90.1	30.89
1 - 14Q3		0.66	6.31	144.53	18.88	90.1	30.89
1 - 14Q4		0.66	6.31	144.53	18.88	90.1	30.89
1 - 15Q1		0.6	2.65	143.63	18.73	92.11	21.45
1 - 15Q2		0.6	2.65	143.63	18.73	92.11	21.45
1 - 15Q3		0.6	2.65	143.63	18.73	92.11	21.45
1 - 15Q4		0.6	2.65	143.63	18.73	92.11	21.45
1 - 16Q1		0.58	-1.62	144.08	18.8	84.73	20.72
1 - 16Q2		0.58	-1.62	144.08	18.8	84.73	20.72
1 - 16Q3		0.58	-1.62	144.08	18.8	84.73	20.72
1 - 16Q4		0.58	-1.62	144.08	18.8	84.73	20.72
1 - 17Q1		0.59	0.81	143.85	18.77	88.42	26.35
1 - 17Q2		0.59	0.81	143.85	18.77	88.42	26.35
1 - 17Q3		0.59	0.81	143.85	18.77	88.42	26.35
1 - 17Q4		0.59	0.81	143.85	18.77	88.42	26.35
1 - 18Q1		0.67	1.94	143.96	18.79	86.57	33
1 - 18Q2		0.67	1.94	143.96	18.79	86.57	33
1 - 18Q3		0.67	1.94	143.96	18.79	86.57	33
1 - 18Q4		0.67	1.94	143.96	18.79	86.57	33
1 - 19Q1		0.63	1.37	143.91	19.96	87.5	29.67
1 - 19Q2		0.63	1.37	143.91	19.96	87.5	29.67
1 - 19Q3		0.63	1.37	143.91	19.96	87.5	29.67
1 - 19Q4		0.63	1.37	143.91	19.96	87.5	29.67
1 - 20Q1		0.65	1.65	143.94	19.16	87.03	31.34
1 - 20Q2		0.65	1.65	143.94	19.16	87.03	31.34
1 - 20Q3		0.65	1.65	143.94	19.16	87.03	31.34
1 - 20Q4		0.65	1.65	143.94	19.16	87.03	31.34
1 - 21Q1		0.62	6.59	138.91	17.58	93.31	39.34
1 - 21Q2		0.62	6.59	138.91	17.58	93.31	39.34
1 - 21Q3		0.62	6.59	138.91	17.58	93.31	39.34
1 - 21Q4		0.62	6.59	138.91	17.58	93.31	39.34
1 - 22Q1		0.61	6.76	127.24	18.43	84.14	40.8
1 - 22Q2		0.61	6.76	127.24	18.43	84.14	40.8
1 - 22Q3		0.61	6.76	127.24	18.43	84.14	40.8
1 - 22Q4		0.61	6.76	127.24	18.43	84.14	40.8

1 - 23Q1		0.48	8.04	120.64	15.85	85.39	36.06
1 - 23Q2		0.48	8.04	120.64	15.85	85.39	36.06
1 - 23Q3		0.48	8.04	120.64	15.85	85.39	36.06
1 - 23Q4		0.48	8.04	120.64	15.85	85.39	36.06
2 - 80Q1	Angola	0.64	2.41	60.66	16.62	142.74	NA
2 - 80Q2		0.64	2.41	60.66	16.62	142.74	NA
2 - 80Q3		0.64	2.41	60.66	16.62	142.74	NA
2 - 80Q4		0.64	2.41	60.66	16.62	142.74	NA
2 - 81Q1		0.61	-4.4	58.56	17.62	123.54	NA
2 - 81Q2		0.61	-4.4	58.56	17.62	123.54	NA
2 - 81Q3		0.61	-4.4	58.56	17.62	123.54	NA
2 - 81Q4		0.61	-4.4	58.56	17.62	123.54	NA
2 - 82Q1		0.52	0	60.32	17.07	114.48	NA
2 - 82Q2		0.52	0	60.32	17.07	114.48	NA
2 - 82Q3		0.52	0	60.32	17.07	114.48	NA
2 - 82Q4		0.52	0	60.32	17.07	114.48	NA
2 - 83Q1		0.55	4.2	63.27	20.31	103.94	NA
2 - 83Q2		0.55	4.2	63.27	20.31	103.94	NA
2 - 83Q3		0.55	4.2	63.27	20.31	103.94	NA
2 - 83Q4		0.55	4.2	63.27	20.31	103.94	NA
2 - 84Q1		0.52	6	52.21	19.89	91.82	NA
2 - 84Q2		0.52	6	52.21	19.89	91.82	NA
2 - 84Q3		0.52	6	52.21	19.89	91.82	NA
2 - 84Q4		0.52	6	52.21	19.89	91.82	NA
2 - 85Q1		0.47	3.5	60.63	20.38	73.38	10.19
2 - 85Q2		0.47	3.5	60.63	20.38	73.38	10.19
2 - 85Q3		0.47	3.5	60.63	20.38	73.38	10.19
2 - 85Q4		0.47	3.5	60.63	20.38	73.38	10.19
2 - 86Q1		0.45	2.9	58.53	22.02	79.39	9.94
2 - 86Q2		0.45	2.9	58.53	22.02	79.39	9.94
2 - 86Q3		0.45	2.9	58.53	22.02	79.39	9.94
2 - 86Q4		0.45	2.9	58.53	22.02	79.39	9.94
2 - 87Q1		0.54	4.08	56.79	22.1	79.46	6.38
2 - 87Q2		0.54	4.08	56.79	22.1	79.46	6.38
2 - 87Q3		0.54	4.08	56.79	22.1	79.46	6.38
2 - 87Q4		0.54	4.08	56.79	22.1	79.46	6.38
2 - 88Q1		0.46	6.13	55.2	25.48	77.87	14.39
2 - 88Q2		0.46	6.13	55.2	25.48	77.87	14.39
2 - 88Q3		0.46	6.13	55.2	25.48	77.87	14.39
2 - 88Q4		0.46	6.13	55.2	25.48	77.87	14.39
2 - 89Q1		0.44	0.04	53.6	25.48	77.6	12.99
2 - 89Q2		0.44	0.04	53.6	25.48	77.6	12.99
2 - 89Q3		0.44	0.04	53.6	25.48	77.6	12.99
2 - 89Q4		0.44	0.04	53.6	25.48	77.6	12.99

2 - 90Q1		0.53	-3.45	53.17	24.1	73.04	17.06
2 - 90Q2		0.53	-3.45	53.17	24.1	73.04	17.06
2 - 90Q3		0.53	-3.45	53.17	24.1	73.04	17.06
2 - 90Q4		0.53	-3.45	53.17	24.1	73.04	17.06
2 - 91Q1		0.53	0.99	54.45	24.96	66.8	18.96
2 - 91Q2		0.53	0.99	54.45	24.96	66.8	18.96
2 - 91Q3		0.53	0.99	54.45	24.96	66.8	18.96
2 - 91Q4		0.53	0.99	54.45	24.96	66.8	18.96
2 - 92Q1		0.5	-5.84	53.49	24.44	64.25	26.3
2 - 92Q2		0.5	-5.84	53.49	24.44	64.25	26.3
2 - 92Q3		0.5	-5.84	53.49	24.44	64.25	26.3
2 - 92Q4		0.5	-5.84	53.49	24.44	64.25	26.3
2 - 93Q1		0.53	-23.98	52.01	22.78	65.53	28.91
2 - 93Q2		0.53	-23.98	52.01	22.78	65.53	28.91
2 - 93Q3		0.53	-23.98	52.01	22.78	65.53	28.91
2 - 93Q4		0.53	-23.98	52.01	22.78	65.53	28.91
2 - 94Q1		0.5	1.34	50.65	23.5	64.89	38.6
2 - 94Q2		0.5	1.34	50.65	23.5	64.89	38.6
2 - 94Q3		0.5	1.34	50.65	23.5	64.89	38.6
2 - 94Q4		0.5	1.34	50.65	23.5	64.89	38.6
2 - 95Q1		0.77	15	49.26	23.87	65.21	39.08
2 - 95Q2		0.77	15	49.26	23.87	65.21	39.08
2 - 95Q3		0.77	15	49.26	23.87	65.21	39.08
2 - 95Q4		0.77	15	49.26	23.87	65.21	39.08
2 - 96Q1		0.79	13.54	51.11	22.12	65.05	35.75
2 - 96Q2		0.79	13.54	51.11	22.12	65.05	35.75
2 - 96Q3		0.79	13.54	51.11	22.12	65.05	35.75
2 - 96Q4		0.79	13.54	51.11	22.12	65.05	35.75
2 - 97Q1		0.79	7.27	69.33	24.71	65.13	35.88
2 - 97Q2		0.79	7.27	69.33	24.71	65.13	35.88
2 - 97Q3		0.79	7.27	69.33	24.71	65.13	35.88
2 - 97Q4		0.79	7.27	69.33	24.71	65.13	35.88
2 - 98Q1		0.74	4.69	73.31	25.22	71.53	42.37
2 - 98Q2		0.74	4.69	73.31	25.22	71.53	42.37
2 - 98Q3		0.74	4.69	73.31	25.22	71.53	42.37
2 - 98Q4		0.74	4.69	73.31	25.22	71.53	42.37
2 - 99Q1		0.8	2.18	71.91	26.68	68.33	44.65
2 - 99Q2		0.8	2.18	71.91	26.68	68.33	44.65
2 - 99Q3		0.8	2.18	71.91	26.68	68.33	44.65
2 - 99Q4		0.8	2.18	71.91	26.68	68.33	44.65
2 - 00Q1		0.75	3.05	75.26	28.15	69.93	152.55
2 - 00Q2		0.75	3.05	75.26	28.15	69.93	152.55
2 - 00Q3		0.75	3.05	75.26	28.15	69.93	152.55
2 - 00Q4		0.75	3.05	75.26	28.15	69.93	152.55

2 - 01Q1		0.76	4.21	82.62	31.72	69.13	150.34
2 - 01Q2		0.76	4.21	82.62	31.72	69.13	150.34
2 - 01Q3		0.76	4.21	82.62	31.72	69.13	150.34
2 - 01Q4		0.76	4.21	82.62	31.72	69.13	150.34
2 - 02Q1		0.78	13.67	86.02	31.56	69.53	105.3
2 - 02Q2		0.78	13.67	86.02	31.56	69.53	105.3
2 - 02Q3		0.78	13.67	86.02	31.56	69.53	105.3
2 - 02Q4		0.78	13.67	86.02	31.56	69.53	105.3
2 - 03Q1		0.99	2.99	95.85	27.08	69.33	103.9
2 - 03Q2		0.99	2.99	95.85	27.08	69.33	103.9
2 - 03Q3		0.99	2.99	95.85	27.08	69.33	103.9
2 - 03Q4		0.99	2.99	95.85	27.08	69.33	103.9
2 - 04Q1		1.03	10.95	87.54	31.67	69.43	103.58
2 - 04Q2		1.03	10.95	87.54	31.67	69.43	103.58
2 - 04Q3		1.03	10.95	87.54	31.67	69.43	103.58
2 - 04Q4		1.03	10.95	87.54	31.67	69.43	103.58
2 - 05Q1		0.94	15.03	109.3	34.74	69.38	106.59
2 - 05Q2		0.94	15.03	109.3	34.74	69.38	106.59
2 - 05Q3		0.94	15.03	109.3	34.74	69.38	106.59
2 - 05Q4		0.94	15.03	109.3	34.74	69.38	106.59
2 - 06Q1		1.01	11.55	144.72	37.96	69.41	94.63
2 - 06Q2		1.01	11.55	144.72	37.96	69.41	94.63
2 - 06Q3		1.01	11.55	144.72	37.96	69.41	94.63
2 - 06Q4		1.01	11.55	144.72	37.96	69.41	94.63
2 - 07Q1		1.12	14.01	133.27	41.8	98.97	108.06
2 - 07Q2		1.12	14.01	133.27	41.8	98.97	108.06
2 - 07Q3		1.12	14.01	133.27	41.8	98.97	108.06
2 - 07Q4		1.12	14.01	133.27	41.8	98.97	108.06
2 - 08Q1		1.16	11.17	172.38	42.99	105.18	121.36
2 - 08Q2		1.16	11.17	172.38	42.99	105.18	121.36
2 - 08Q3		1.16	11.17	172.38	42.99	105.18	121.36
2 - 08Q4		1.16	11.17	172.38	42.99	105.18	121.36
2 - 09Q1		1.21	0.86	189.26	43.85	104.13	122.45
2 - 09Q2		1.21	0.86	189.26	43.85	104.13	122.45
2 - 09Q3		1.21	0.86	189.26	43.85	104.13	122.45
2 - 09Q4		1.21	0.86	189.26	43.85	104.13	122.45
2 - 10Q1		1.22	4.86	206.45	48.01	105.78	104.12
2 - 10Q2		1.22	4.86	206.45	48.01	105.78	104.12
2 - 10Q3		1.22	4.86	206.45	48.01	105.78	104.12
2 - 10Q4		1.22	4.86	206.45	48.01	105.78	104.12
2 - 11Q1		1.22	3.47	207.01	46.51	119.53	99.98
2 - 11Q2		1.22	3.47	207.01	46.51	119.53	99.98
2 - 11Q3		1.22	3.47	207.01	46.51	119.53	99.98
2 - 11Q4		1.22	3.47	207.01	46.51	119.53	99.98

2 - 12Q1		1.2	8.54	219.25	48.31	112.66	91.8
2 - 12Q2		1.2	8.54	219.25	48.31	112.66	91.8
2 - 12Q3		1.2	8.54	219.25	48.31	112.66	91.8
2 - 12Q4		1.2	8.54	219.25	48.31	112.66	91.8
2 - 13Q1		1.26	4.95	280.21	47.41	116.09	86.81
2 - 13Q2		1.26	4.95	280.21	47.41	116.09	86.81
2 - 13Q3		1.26	4.95	280.21	47.41	116.09	86.81
2 - 13Q4		1.26	4.95	280.21	47.41	116.09	86.81
2 - 14Q1		1.29	4.82	312.23	47.86	114.37	79.33
2 - 14Q2		1.29	4.82	312.23	47.86	114.37	79.33
2 - 14Q3		1.29	4.82	312.23	47.86	114.37	79.33
2 - 14Q4		1.29	4.82	312.23	47.86	114.37	79.33
2 - 15Q1		1.26	0.94	296.22	47.63	113.48	62.89
2 - 15Q2		1.26	0.94	296.22	47.63	113.48	62.89
2 - 15Q3		1.26	0.94	296.22	47.63	113.48	62.89
2 - 15Q4		1.26	0.94	296.22	47.63	113.48	62.89
2 - 16Q1		1.23	-2.58	304.23	47.74	113.93	53.37
2 - 16Q2		1.23	-2.58	304.23	47.74	113.93	53.37
2 - 16Q3		1.23	-2.58	304.23	47.74	113.93	53.37
2 - 16Q4		1.23	-2.58	304.23	47.74	113.93	53.37
2 - 17Q1		1.03	-0.15	300.22	47.69	113.7	52.26
2 - 17Q2		1.03	-0.15	300.22	47.69	113.7	52.26
2 - 17Q3		1.03	-0.15	300.22	47.69	113.7	52.26
2 - 17Q4		1.03	-0.15	300.22	47.69	113.7	52.26
2 - 18Q1		0.89	-2.13	302.22	47.72	113.81	52.81
2 - 18Q2		0.89	-2.13	302.22	47.72	113.81	52.81
2 - 18Q3		0.89	-2.13	302.22	47.72	113.81	52.81
2 - 18Q4		0.89	-2.13	302.22	47.72	113.81	52.81
2 - 19Q1		0.96	-1.14	301.22	47.7	113.76	52.54
2 - 19Q2		0.96	-1.14	301.22	47.7	113.76	52.54
2 - 19Q3		0.96	-1.14	301.22	47.7	113.76	52.54
2 - 19Q4		0.96	-1.14	301.22	47.7	113.76	52.54
2 - 20Q1		0.92	-1.64	301.72	47.71	113.79	52.67
2 - 20Q2		0.92	-1.64	301.72	47.71	113.79	52.67
2 - 20Q3		0.92	-1.64	301.72	47.71	113.79	52.67
2 - 20Q4		0.92	-1.64	301.72	47.71	113.79	52.67
2 - 21Q1		0.45	2.9	58.53	22.02	79.39	9.94
2 - 21Q2		0.45	2.9	58.53	22.02	79.39	9.94
2 - 21Q3		0.45	2.9	58.53	22.02	79.39	9.94
2 - 21Q4		0.45	2.9	58.53	22.02	79.39	9.94
2 - 22Q1		0.54	4.08	56.79	22.1	79.46	6.38
2 - 22Q2		0.54	4.08	56.79	22.1	79.46	6.38
2 - 22Q3		0.54	4.08	56.79	22.1	79.46	6.38
2 - 22Q4		0.54	4.08	56.79	22.1	79.46	6.38

2 - 23Q1		0.46	6.13	55.2	25.48	77.87	14.39
2 - 23Q2		0.46	6.13	55.2	25.48	77.87	14.39
2 - 23Q3		0.46	6.13	55.2	25.48	77.87	14.39
2 - 23Q4		0.46	6.13	55.2	25.48	77.87	14.39
3 - 80Q1	Algeria	3.46	0.79	330.304	99.73	94.77	64.68
3 - 80Q2		3.46	0.79	330.304	99.73	94.77	64.68
3 - 80Q3		3.46	0.79	330.304	99.73	94.77	64.68
3 - 80Q4		3.46	0.79	330.304	99.73	94.77	64.68
3 - 81Q1		2.34	3	363.443	99.66	93.68	65.46
3 - 81Q2		2.34	3	363.443	99.66	93.68	65.46
3 - 81Q3		2.34	3	363.443	99.66	93.68	65.46
3 - 81Q4		2.34	3	363.443	99.66	93.68	65.46
3 - 82Q1		1.92	6.4	406.055	99.7	92.56	59.92
3 - 82Q2		1.92	6.4	406.055	99.7	92.56	59.92
3 - 82Q3		1.92	6.4	406.055	99.7	92.56	59.92
3 - 82Q4		1.92	6.4	406.055	99.7	92.56	59.92
3 - 83Q1		2.49	5.4	417.498	99.84	91.36	53.74
3 - 83Q2		2.49	5.4	417.498	99.84	91.36	53.74
3 - 83Q3		2.49	5.4	417.498	99.84	91.36	53.74
3 - 83Q4		2.49	5.4	417.498	99.84	91.36	53.74
3 - 84Q1		3.27	5.6	441.288	99.68	90.95	53.18
3 - 84Q2		3.27	5.6	441.288	99.68	90.95	53.18
3 - 84Q3		3.27	5.6	441.288	99.68	90.95	53.18
3 - 84Q4		3.27	5.6	441.288	99.68	90.95	53.18
3 - 85Q1		3.24	3.7	466.487	99.62	90.08	50.33
3 - 85Q2		3.24	3.7	466.487	99.62	90.08	50.33
3 - 85Q3		3.24	3.7	466.487	99.62	90.08	50.33
3 - 85Q4		3.24	3.7	466.487	99.62	90.08	50.33
3 - 86Q1		3.3	0.4	485.274	99.81	89.05	36.03
3 - 86Q2		3.3	0.4	485.274	99.81	89.05	36.03
3 - 86Q3		3.3	0.4	485.274	99.81	89.05	36.03
3 - 86Q4		3.3	0.4	485.274	99.81	89.05	36.03
3 - 87Q1		3.54	-0.7	455.408	99.76	90.25	32.68
3 - 87Q2		3.54	-0.7	455.408	99.76	90.25	32.68
3 - 87Q3		3.54	-0.7	455.408	99.76	90.25	32.68
3 - 87Q4		3.54	-0.7	455.408	99.76	90.25	32.68
3 - 88Q1		3.43	-1	481.887	99.9	91.76	38.11
3 - 88Q2		3.43	-1	481.887	99.9	91.76	38.11
3 - 88Q3		3.43	-1	481.887	99.9	91.76	38.11
3 - 88Q4		3.43	-1	481.887	99.9	91.76	38.11
3 - 89Q1		3.19	4.4	522.142	99.86	92	47.15
3 - 89Q2		3.19	4.4	522.142	99.86	92	47.15
3 - 89Q3		3.19	4.4	522.142	99.86	92	47.15
3 - 89Q4		3.19	4.4	522.142	99.86	92	47.15

3 - 90Q1		2.64	0.8	531.584	99.94	92.59	48.38
3 - 90Q2		2.64	0.8	531.584	99.94	92.59	48.38
3 - 90Q3		2.64	0.8	531.584	99.94	92.59	48.38
3 - 90Q4		2.64	0.8	531.584	99.94	92.59	48.38
3 - 91Q1		2.54	-1.2	532.49	99.9	94.45	52.72
3 - 91Q2		2.54	-1.2	532.49	99.9	94.45	52.72
3 - 91Q3		2.54	-1.2	532.49	99.9	94.45	52.72
3 - 91Q4		2.54	-1.2	532.49	99.9	94.45	52.72
3 - 92Q1		2.45	1.8	559.783	99.92	96.48	49.19
3 - 92Q2		2.45	1.8	559.783	99.92	96.48	49.19
3 - 92Q3		2.45	1.8	559.783	99.92	96.48	49.19
3 - 92Q4		2.45	1.8	559.783	99.92	96.48	49.19
3 - 93Q1		2.66	-2.1	547.991	99.91	96.79	44.92
3 - 93Q2		2.66	-2.1	547.991	99.91	96.79	44.92
3 - 93Q3		2.66	-2.1	547.991	99.91	96.79	44.92
3 - 93Q4		2.66	-2.1	547.991	99.91	96.79	44.92
3 - 94Q1		2.54	-0.9	550.972	99.91	97.42	48.58
3 - 94Q2		2.54	-0.9	550.972	99.91	97.42	48.58
3 - 94Q3		2.54	-0.9	550.972	99.91	97.42	48.58
3 - 94Q4		2.54	-0.9	550.972	99.91	97.42	48.58
3 - 95Q1		2.54	3.8	559.918	99.87	97.44	55.19
3 - 95Q2		2.54	3.8	559.918	99.87	97.44	55.19
3 - 95Q3		2.54	3.8	559.918	99.87	97.44	55.19
3 - 95Q4		2.54	3.8	559.918	99.87	97.44	55.19
3 - 96Q1		2.44	4.1	570.518	99.84	98.59	53.71
3 - 96Q2		2.44	4.1	570.518	99.84	98.59	53.71
3 - 96Q3		2.44	4.1	570.518	99.84	98.59	53.71
3 - 96Q4		2.44	4.1	570.518	99.84	98.59	53.71
3 - 97Q1		2.45	1.1	575.699	99.76	99.75	52.24
3 - 97Q2		2.45	1.1	575.699	99.76	99.75	52.24
3 - 97Q3		2.45	1.1	575.699	99.76	99.75	52.24
3 - 97Q4		2.45	1.1	575.699	99.76	99.75	52.24
3 - 98Q1		2.47	5.1	618.493	99.71	100.91	45.09
3 - 98Q2		2.47	5.1	618.493	99.71	100.91	45.09
3 - 98Q3		2.47	5.1	618.493	99.71	100.91	45.09
3 - 98Q4		2.47	5.1	618.493	99.71	100.91	45.09
3 - 99Q1		2.53	3.2	652.801	99.74	102.75	50.93
3 - 99Q2		2.53	3.2	652.801	99.74	102.75	50.93
3 - 99Q3		2.53	3.2	652.801	99.74	102.75	50.93
3 - 99Q4		2.53	3.2	652.801	99.74	102.75	50.93
3 - 00Q1		2.53	3.8	683.295	99.82	105.16	62.86
3 - 00Q2		2.53	3.8	683.295	99.82	105.16	62.86
3 - 00Q3		2.53	3.8	683.295	99.82	105.16	62.86
3 - 00Q4		2.53	3.8	683.295	99.82	105.16	62.86

3 - 01Q1		2.38	3	709.091	99.78	104.02	58.71
3 - 01Q2		2.38	3	709.091	99.78	104.02	58.71
3 - 01Q3		2.38	3	709.091	99.78	104.02	58.71
3 - 01Q4		2.38	3	709.091	99.78	104.02	58.71
3 - 02Q1		2.52	5.6	730.809	99.74	105.14	61.14
3 - 02Q2		2.52	5.6	730.809	99.74	105.14	61.14
3 - 02Q3		2.52	5.6	730.809	99.74	105.14	61.14
3 - 02Q4		2.52	5.6	730.809	99.74	105.14	61.14
3 - 03Q1		2.6	7.2	786.414	99.73	105.93	62.12
3 - 03Q2		2.6	7.2	786.414	99.73	105.93	62.12
3 - 03Q3		2.6	7.2	786.414	99.73	105.93	62.12
3 - 03Q4		2.6	7.2	786.414	99.73	105.93	62.12
3 - 04Q1		2.6	4.3	804.107	99.74	106.89	65.7
3 - 04Q2		2.6	4.3	804.107	99.74	106.89	65.7
3 - 04Q3		2.6	4.3	804.107	99.74	106.89	65.7
3 - 04Q4		2.6	4.3	804.107	99.74	106.89	65.7
3 - 05Q1		2.68	5.9	890.626	99.61	107.59	71.28
3 - 05Q2		2.68	5.9	890.626	99.61	107.59	71.28
3 - 05Q3		2.68	5.9	890.626	99.61	107.59	71.28
3 - 05Q4		2.68	5.9	890.626	99.61	107.59	71.28
3 - 06Q1		2.79	1.7	862.43	99.74	108.16	70.73
3 - 06Q2		2.79	1.7	862.43	99.74	108.16	70.73
3 - 06Q3		2.79	1.7	862.43	99.74	108.16	70.73
3 - 06Q4		2.79	1.7	862.43	99.74	108.16	70.73
3 - 07Q1		2.94	3.4	894.285	99.75	109.53	71.94
3 - 07Q2		2.94	3.4	894.285	99.75	109.53	71.94
3 - 07Q3		2.94	3.4	894.285	99.75	109.53	71.94
3 - 07Q4		2.94	3.4	894.285	99.75	109.53	71.94
3 - 08Q1		2.99	2.4	947.291	99.82	109.23	76.69
3 - 08Q2		2.99	2.4	947.291	99.82	109.23	76.69
3 - 08Q3		2.99	2.4	947.291	99.82	109.23	76.69
3 - 08Q4		2.99	2.4	947.291	99.82	109.23	76.69
3 - 09Q1		3.19	1.6	866.307	99.81	112.36	71.32
3 - 09Q2		3.19	1.6	866.307	99.81	112.36	71.32
3 - 09Q3		3.19	1.6	866.307	99.81	112.36	71.32
3 - 09Q4		3.19	1.6	866.307	99.81	112.36	71.32
3 - 10Q1		3.14	3.6	1016.637	99.85	115.34	69.87
3 - 10Q2		3.14	3.6	1016.637	99.85	115.34	69.87
3 - 10Q3		3.14	3.6	1016.637	99.85	115.34	69.87
3 - 10Q4		3.14	3.6	1016.637	99.85	115.34	69.87
3 - 11Q1		3.22	2.9	1123.333	99.89	116.57	67.47
3 - 11Q2		3.22	2.9	1123.333	99.89	116.57	67.47
3 - 11Q3		3.22	2.9	1123.333	99.89	116.57	67.47
3 - 11Q4		3.22	2.9	1123.333	99.89	116.57	67.47

3 - 12Q1		3.39	3.4	1237.967	99.86	118.08	65.4
3 - 12Q2		3.39	3.4	1237.967	99.86	118.08	65.4
3 - 12Q3		3.39	3.4	1237.967	99.86	118.08	65.4
3 - 12Q4		3.39	3.4	1237.967	99.86	118.08	65.4
3 - 13Q1		3.41	2.8	1278.915	99.91	119.54	63.61
3 - 13Q2		3.41	2.8	1278.915	99.91	119.54	63.61
3 - 13Q3		3.41	2.8	1278.915	99.91	119.54	63.61
3 - 13Q4		3.41	2.8	1278.915	99.91	119.54	63.61
3 - 14Q1		3.57	3.8	1362.872	99.98	118.5	62.15
3 - 14Q2		3.57	3.8	1362.872	99.98	118.5	62.15
3 - 14Q3		3.57	3.8	1362.872	99.98	118.5	62.15
3 - 14Q4		3.57	3.8	1362.872	99.98	118.5	62.15
3 - 15Q1		3.67	3.7	1320.89	99.94	115.88	59.7
3 - 15Q2		3.67	3.7	1320.89	99.94	115.88	59.7
3 - 15Q3		3.67	3.7	1320.89	99.94	115.88	59.7
3 - 15Q4		3.67	3.7	1320.89	99.94	115.88	59.7
3 - 16Q1		3.54	3.2	1341.88	99.96	113.83	55.93
3 - 16Q2		3.54	3.2	1341.88	99.96	113.83	55.93
3 - 16Q3		3.54	3.2	1341.88	99.96	113.83	55.93
3 - 16Q4		3.54	3.2	1341.88	99.96	113.83	55.93
3 - 17Q1		3.51	1.3	1331.39	99.95	111.76	55.88
3 - 17Q2		3.51	1.3	1331.39	99.95	111.76	55.88
3 - 17Q3		3.51	1.3	1331.39	99.95	111.76	55.88
3 - 17Q4		3.51	1.3	1331.39	99.95	111.76	55.88
3 - 18Q1		3.59	1.4	1336.64	99.96	109.88	57.96
3 - 18Q2		3.59	1.4	1336.64	99.96	109.88	57.96
3 - 18Q3		3.59	1.4	1336.64	99.96	109.88	57.96
3 - 18Q4		3.59	1.4	1336.64	99.96	109.88	57.96
3 - 19Q1		3.55	1.35	1334.01	99.95	110.82	56.92
3 - 19Q2		3.55	1.35	1334.01	99.95	110.82	56.92
3 - 19Q3		3.55	1.35	1334.01	99.95	110.82	56.92
3 - 19Q4		3.55	1.35	1334.01	99.95	110.82	56.92
3 - 20Q1		3.57	1.37	1335.32	99.96	110.35	57.44
3 - 20Q2		3.57	1.37	1335.32	99.96	110.35	57.44
3 - 20Q3		3.57	1.37	1335.32	99.96	110.35	57.44
3 - 20Q4		3.57	1.37	1335.32	99.96	110.35	57.44
3 - 21Q1		2.38	3	709.091	99.78	104.02	58.71
3 - 21Q2		2.38	3	709.091	99.78	104.02	58.71
3 - 21Q3		2.38	3	709.091	99.78	104.02	58.71
3 - 21Q4		2.38	3	709.091	99.78	104.02	58.71
3 - 22Q1		2.52	5.6	730.809	99.74	105.14	61.14
3 - 22Q2		2.52	5.6	730.809	99.74	105.14	61.14
3 - 22Q3		2.52	5.6	730.809	99.74	105.14	61.14
3 - 22Q4		2.52	5.6	730.809	99.74	105.14	61.14

3 - 23Q1		2.6	7.2	786.414	99.73	105.93	62.12
3 - 23Q2		2.6	7.2	786.414	99.73	105.93	62.12
3 - 23Q3		2.6	7.2	786.414	99.73	105.93	62.12
3 - 23Q4		2.6	7.2	786.414	99.73	105.93	62.12
4 - 80Q1	Libya	8.36	NA	1120.06	98.23	NA	NA
4 - 80Q2		8.36	NA	1120.06	98.23	NA	NA
4 - 80Q3		8.36	NA	1120.06	98.23	NA	NA
4 - 80Q4		8.36	NA	1120.06	98.23	NA	NA
4 - 81Q1		8.61	NA	1085.2	98.36	NA	NA
4 - 81Q2		8.61	NA	1085.2	98.36	NA	NA
4 - 81Q3		8.61	NA	1085.2	98.36	NA	NA
4 - 81Q4		8.61	NA	1085.2	98.36	NA	NA
4 - 82Q1		8.84	NA	1055.03	98.49	NA	NA
4 - 82Q2		8.84	NA	1055.03	98.49	NA	NA
4 - 82Q3		8.84	NA	1055.03	98.49	NA	NA
4 - 82Q4		8.84	NA	1055.03	98.49	NA	NA
4 - 83Q1		8.41	NA	1030.24	98.52	NA	NA
4 - 83Q2		8.41	NA	1030.24	98.52	NA	NA
4 - 83Q3		8.41	NA	1030.24	98.52	NA	NA
4 - 83Q4		8.41	NA	1030.24	98.52	NA	NA
4 - 84Q1		7.64	NA	1011.29	98.62	NA	NA
4 - 84Q2		7.64	NA	1011.29	98.62	NA	NA
4 - 84Q3		7.64	NA	1011.29	98.62	NA	NA
4 - 84Q4		7.64	NA	1011.29	98.62	NA	NA
4 - 85Q1		8.11	NA	998.51	98.77	NA	NA
4 - 85Q2		8.11	NA	998.51	98.77	NA	NA
4 - 85Q3		8.11	NA	998.51	98.77	NA	NA
4 - 85Q4		8.11	NA	998.51	98.77	NA	NA
4 - 86Q1		8.53	NA	1048.92	98.76	NA	NA
4 - 86Q2		8.53	NA	1048.92	98.76	NA	NA
4 - 86Q3		8.53	NA	1048.92	98.76	NA	NA
4 - 86Q4		8.53	NA	1048.92	98.76	NA	NA
4 - 87Q1		7.92	NA	1429.29	98.86	NA	NA
4 - 87Q2		7.92	NA	1429.29	98.86	NA	NA
4 - 87Q3		7.92	NA	1429.29	98.86	NA	NA
4 - 87Q4		7.92	NA	1429.29	98.86	NA	NA
4 - 88Q1		8.62	NA	1534.43	98.82	NA	NA
4 - 88Q2		8.62	NA	1534.43	98.82	NA	NA
4 - 88Q3		8.62	NA	1534.43	98.82	NA	NA
4 - 88Q4		8.62	NA	1534.43	98.82	NA	NA
4 - 89Q1		8.62	NA	1497.13	98.91	NA	NA
4 - 89Q2		8.62	NA	1497.13	98.91	NA	NA
4 - 89Q3		8.62	NA	1497.13	98.91	NA	NA
4 - 89Q4		8.62	NA	1497.13	98.91	NA	NA

4 - 90Q1		8.13	56.58	1576.86	98.88	113.03	70.8
4 - 90Q2		8.13	56.58	1576.86	98.88	113.03	70.8
4 - 90Q3		8.13	56.58	1576.86	98.88	113.03	70.8
4 - 90Q4		8.13	56.58	1576.86	98.88	113.03	70.8
4 - 91Q1		7.33	56.58	1657.7	98.9	111.5	64.6
4 - 91Q2		7.33	56.58	1657.7	98.9	111.5	64.6
4 - 91Q3		7.33	56.58	1657.7	98.9	111.5	64.6
4 - 91Q4		7.33	56.58	1657.7	98.9	111.5	64.6
4 - 92Q1		6.51	56.58	1753	98.89	112.26	56.06
4 - 92Q2		6.51	56.58	1753	98.89	112.26	56.06
4 - 92Q3		6.51	56.58	1753	98.89	112.26	56.06
4 - 92Q4		6.51	56.58	1753	98.89	112.26	56.06
4 - 93Q1		6.49	56.58	1808.57	98.93	113.06	59.79
4 - 93Q2		6.49	56.58	1808.57	98.93	113.06	59.79
4 - 93Q3		6.49	56.58	1808.57	98.93	113.06	59.79
4 - 93Q4		6.49	56.58	1808.57	98.93	113.06	59.79
4 - 94Q1		7.4	56.58	1820.44	99.05	112.66	53.15
4 - 94Q2		7.4	56.58	1820.44	99.05	112.66	53.15
4 - 94Q3		7.4	56.58	1820.44	99.05	112.66	53.15
4 - 94Q4		7.4	56.58	1820.44	99.05	112.66	53.15
4 - 95Q1		7.58	56.58	1770.53	99.11	112.86	51.59
4 - 95Q2		7.58	56.58	1770.53	99.11	112.86	51.59
4 - 95Q3		7.58	56.58	1770.53	99.11	112.86	51.59
4 - 95Q4		7.58	56.58	1770.53	99.11	112.86	51.59
4 - 96Q1		7.82	56.58	1787.67	99.14	108.82	52.55
4 - 96Q2		7.82	56.58	1787.67	99.14	108.82	52.55
4 - 96Q3		7.82	56.58	1787.67	99.14	108.82	52.55
4 - 96Q4		7.82	56.58	1787.67	99.14	108.82	52.55
4 - 97Q1		7.61	56.58	1802.85	99.14	110.84	48.63
4 - 97Q2		7.61	56.58	1802.85	99.14	110.84	48.63
4 - 97Q3		7.61	56.58	1802.85	99.14	110.84	48.63
4 - 97Q4		7.61	56.58	1802.85	99.14	110.84	48.63
4 - 98Q1		7.68	56.58	2097.07	99.13	109.83	40.25
4 - 98Q2		7.68	56.58	2097.07	99.13	109.83	40.25
4 - 98Q3		7.68	56.58	2097.07	99.13	109.83	40.25
4 - 98Q4		7.68	56.58	2097.07	99.13	109.83	40.25
4 - 99Q1		7.21	56.58	2176.68	99.1	110.33	34.8
4 - 99Q2		7.21	56.58	2176.68	99.1	110.33	34.8
4 - 99Q3		7.21	56.58	2176.68	99.1	110.33	34.8
4 - 99Q4		7.21	56.58	2176.68	99.1	110.33	34.8
4 - 00Q1		7.44	3.68	2221.77	99.12	110.08	45.28
4 - 00Q2		7.44	3.68	2221.77	99.12	110.08	45.28
4 - 00Q3		7.44	3.68	2221.77	99.12	110.08	45.28
4 - 00Q4		7.44	3.68	2221.77	99.12	110.08	45.28

4 - 01Q1		7.61	-1.76	2255.64	99.12	110.21	43.17
4 - 01Q2		7.61	-1.76	2255.64	99.12	110.21	43.17
4 - 01Q3		7.61	-1.76	2255.64	99.12	110.21	43.17
4 - 01Q4		7.61	-1.76	2255.64	99.12	110.21	43.17
4 - 02Q1		7.88	-0.96	2772.15	99.15	110.14	78.86
4 - 02Q2		7.88	-0.96	2772.15	99.15	110.14	78.86
4 - 02Q3		7.88	-0.96	2772.15	99.15	110.14	78.86
4 - 02Q4		7.88	-0.96	2772.15	99.15	110.14	78.86
4 - 03Q1		7.88	13.02	2947.76	99.16	110.18	90.61
4 - 03Q2		7.88	13.02	2947.76	99.16	110.18	90.61
4 - 03Q3		7.88	13.02	2947.76	99.16	110.18	90.61
4 - 03Q4		7.88	13.02	2947.76	99.16	110.18	90.61
4 - 04Q1		7.97	4.46	3106.22	99.18	110.16	96.13
4 - 04Q2		7.97	4.46	3106.22	99.18	110.16	96.13
4 - 04Q3		7.97	4.46	3106.22	99.18	110.16	96.13
4 - 04Q4		7.97	4.46	3106.22	99.18	110.16	96.13
4 - 05Q1		8.47	11.87	3427.89	99.14	110.17	90.86
4 - 05Q2		8.47	11.87	3427.89	99.14	110.17	90.86
4 - 05Q3		8.47	11.87	3427.89	99.14	110.17	90.86
4 - 05Q4		8.47	11.87	3427.89	99.14	110.17	90.86
4 - 06Q1		8.39	6.5	3792.34	99.14	110.16	101.86
4 - 06Q2		8.39	6.5	3792.34	99.14	110.16	101.86
4 - 06Q3		8.39	6.5	3792.34	99.14	110.16	101.86
4 - 06Q4		8.39	6.5	3792.34	99.14	110.16	101.86
4 - 07Q1		7.75	6.35	3792.77	99.1	110.17	102.22
4 - 07Q2		7.75	6.35	3792.77	99.1	110.17	102.22
4 - 07Q3		7.75	6.35	3792.77	99.1	110.17	102.22
4 - 07Q4		7.75	6.35	3792.77	99.1	110.17	102.22
4 - 08Q1		8.5	2.67	3156.43	99.15	110.17	101.49
4 - 08Q2		8.5	2.67	3156.43	99.15	110.17	101.49
4 - 08Q3		8.5	2.67	3156.43	99.15	110.17	101.49
4 - 08Q4		8.5	2.67	3156.43	99.15	110.17	101.49
4 - 09Q1		8.77	-0.79	3142.33	99.2	107.71	102.06
4 - 09Q2		8.77	-0.79	3142.33	99.2	107.71	102.06
4 - 09Q3		8.77	-0.79	3142.33	99.2	107.71	102.06
4 - 09Q4		8.77	-0.79	3142.33	99.2	107.71	102.06
4 - 10Q1		9.23	5.02	3361.75	99.28	108.94	107.7
4 - 10Q2		9.23	5.02	3361.75	99.28	108.94	107.7
4 - 10Q3		9.23	5.02	3361.75	99.28	108.94	107.7
4 - 10Q4		9.23	5.02	3361.75	99.28	108.94	107.7
4 - 11Q1		6.09	-62.08	2839.08	98.9	103.61	99.62
4 - 11Q2		6.09	-62.08	2839.08	98.9	103.61	99.62
4 - 11Q3		6.09	-62.08	2839.08	98.9	103.61	99.62
4 - 11Q4		6.09	-62.08	2839.08	98.9	103.61	99.62

4 - 12Q1		8.32	123.14	2241.26	99.08	103.25	114.37
4 - 12Q2		8.32	123.14	2241.26	99.08	103.25	114.37
4 - 12Q3		8.32	123.14	2241.26	99.08	103.25	114.37
4 - 12Q4		8.32	123.14	2241.26	99.08	103.25	114.37
4 - 13Q1		8.7	-13.6	2320.6	99.19	103.25	135.26
4 - 13Q2		8.7	-13.6	2320.6	99.19	103.25	135.26
4 - 13Q3		8.7	-13.6	2320.6	99.19	103.25	135.26
4 - 13Q4		8.7	-13.6	2320.6	99.19	103.25	135.26
4 - 14Q1		9.38	-24	1811.06	99.11	105.47	138.9
4 - 14Q2		9.38	-24	1811.06	99.11	105.47	138.9
4 - 14Q3		9.38	-24	1811.06	99.11	105.47	138.9
4 - 14Q4		9.38	-24	1811.06	99.11	105.47	138.9
4 - 15Q1		8.39	-8.86	2124.3	99.13	102.09	114.25
4 - 15Q2		8.39	-8.86	2124.3	99.13	102.09	114.25
4 - 15Q3		8.39	-8.86	2124.3	99.13	102.09	114.25
4 - 15Q4		8.39	-8.86	2124.3	99.13	102.09	114.25
4 - 16Q1		7.88	-2.8	2085.32	99.14	109.01	70.21
4 - 16Q2		7.88	-2.8	2085.32	99.14	109.01	70.21
4 - 16Q3		7.88	-2.8	2085.32	99.14	109.01	70.21
4 - 16Q4		7.88	-2.8	2085.32	99.14	109.01	70.21
4 - 17Q1		8.63	26.68	2006.89	99.13	105.53	89.74
4 - 17Q2		8.63	26.68	2006.89	99.13	105.53	89.74
4 - 17Q3		8.63	26.68	2006.89	99.13	105.53	89.74
4 - 17Q4		8.63	26.68	2006.89	99.13	105.53	89.74
4 - 18Q1		8.83	7.95	2072.17	99.13	105.54	102.35
4 - 18Q2		8.83	7.95	2072.17	99.13	105.54	102.35
4 - 18Q3		8.83	7.95	2072.17	99.13	105.54	102.35
4 - 18Q4		8.83	7.95	2072.17	99.13	105.54	102.35
4 - 19Q1		8.73	17.31	2054.79	99.13	106.69	87.43
4 - 19Q2		8.73	17.31	2054.79	99.13	106.69	87.43
4 - 19Q3		8.73	17.31	2054.79	99.13	106.69	87.43
4 - 19Q4		8.73	17.31	2054.79	99.13	106.69	87.43
4 - 20Q1		8.78	12.63	2044.62	99.13	105.92	93.17
4 - 20Q2		8.78	12.63	2044.62	99.13	105.92	93.17
4 - 20Q3		8.78	12.63	2044.62	99.13	105.92	93.17
4 - 20Q4		8.78	12.63	2044.62	99.13	105.92	93.17
4 - 21Q1		9.61	56.58	1802.85	99.14	110.84	48.63
4 - 21Q2		9.61	56.58	1802.85	99.14	110.84	48.63
4 - 21Q3		9.61	56.58	1802.85	99.14	110.84	48.63
4 - 21Q4		9.61	56.58	1802.85	99.14	110.84	48.63
4 - 22Q1		9.68	56.58	2097.07	99.13	109.83	40.25
4 - 22Q2		9.68	56.58	2097.07	99.13	109.83	40.25
4 - 22Q3		9.68	56.58	2097.07	99.13	109.83	40.25
4 - 22Q4		9.68	56.58	2097.07	99.13	109.83	40.25

4 - 23Q1		9.21	56.58	2176.68	99.1	110.33	34.8
4 - 23Q2		9.21	56.58	2176.68	99.1	110.33	34.8
4 - 23Q3		9.21	56.58	2176.68	99.1	110.33	34.8
4 - 23Q4		9.21	56.58	2176.68	99.1	110.33	34.8
5 - 80Q1	Egypt	1.04	10.01	382	89.16	69.34	73.38
5 - 80Q2		1.04	10.01	382	89.16	69.34	73.38
5 - 80Q3		1.04	10.01	382	89.16	69.34	73.38
5 - 80Q4		1.04	10.01	382	89.16	69.34	73.38
5 - 81Q1		1.15	7.35	418.04	90.44	70.33	74.46
5 - 81Q2		1.15	7.35	418.04	90.44	70.33	74.46
5 - 81Q3		1.15	7.35	418.04	90.44	70.33	74.46
5 - 81Q4		1.15	7.35	418.04	90.44	70.33	74.46
5 - 82Q1		1.24	9.91	458.09	90.92	72.35	64.2
5 - 82Q2		1.24	9.91	458.09	90.92	72.35	64.2
5 - 82Q3		1.24	9.91	458.09	90.92	72.35	64.2
5 - 82Q4		1.24	9.91	458.09	90.92	72.35	64.2
5 - 83Q1		1.22	5.09	503.46	92.16	75.23	57.14
5 - 83Q2		1.22	5.09	503.46	92.16	75.23	57.14
5 - 83Q3		1.22	5.09	503.46	92.16	75.23	57.14
5 - 83Q4		1.22	5.09	503.46	92.16	75.23	57.14
5 - 84Q1		1.33	9.75	521.67	92.84	77.96	52.53
5 - 84Q2		1.33	9.75	521.67	92.84	77.96	52.53
5 - 84Q3		1.33	9.75	521.67	92.84	77.96	52.53
5 - 84Q4		1.33	9.75	521.67	92.84	77.96	52.53
5 - 85Q1		1.3	5.79	497.11	93.42	80.54	46.11
5 - 85Q2		1.3	5.79	497.11	93.42	80.54	46.11
5 - 85Q3		1.3	5.79	497.11	93.42	80.54	46.11
5 - 85Q4		1.3	5.79	497.11	93.42	80.54	46.11
5 - 86Q1		1.47	4.74	590.23	93.26	82.99	36.05
5 - 86Q2		1.47	4.74	590.23	93.26	82.99	36.05
5 - 86Q3		1.47	4.74	590.23	93.26	82.99	36.05
5 - 86Q4		1.47	4.74	590.23	93.26	82.99	36.05
5 - 87Q1		1.44	3.83	620.39	93.74	85.7	35.34
5 - 87Q2		1.44	3.83	620.39	93.74	85.7	35.34
5 - 87Q3		1.44	3.83	620.39	93.74	85.7	35.34
5 - 87Q4		1.44	3.83	620.39	93.74	85.7	35.34
5 - 88Q1		1.4	5.46	635.1	93.69	88.21	52.6
5 - 88Q2		1.4	5.46	635.1	93.69	88.21	52.6
5 - 88Q3		1.4	5.46	635.1	93.69	88.21	52.6
5 - 88Q4		1.4	5.46	635.1	93.69	88.21	52.6
5 - 89Q1		1.32	4.92	657.34	93.9	89.03	50.13
5 - 89Q2		1.32	4.92	657.34	93.9	89.03	50.13
5 - 89Q3		1.32	4.92	657.34	93.9	89.03	50.13
5 - 89Q4		1.32	4.92	657.34	93.9	89.03	50.13

5 - 90Q1		1.55	5.67	677.82	94.07	91.02	52.92
5 - 90Q2		1.55	5.67	677.82	94.07	91.02	52.92
5 - 90Q3		1.55	5.67	677.82	94.07	91.02	52.92
5 - 90Q4		1.55	5.67	677.82	94.07	91.02	52.92
5 - 91Q1		1.56	1.13	694.32	93.89	93.46	62.84
5 - 91Q2		1.56	1.13	694.32	93.89	93.46	62.84
5 - 91Q3		1.56	1.13	694.32	93.89	93.46	62.84
5 - 91Q4		1.56	1.13	694.32	93.89	93.46	62.84
5 - 92Q1		1.57	4.47	698.27	94.05	85.29	59.31
5 - 92Q2		1.57	4.47	698.27	94.05	85.29	59.31
5 - 92Q3		1.57	4.47	698.27	94.05	85.29	59.31
5 - 92Q4		1.57	4.47	698.27	94.05	85.29	59.31
5 - 93Q1		1.53	2.9	714.4	93.96	86.1	55.93
5 - 93Q2		1.53	2.9	714.4	93.96	86.1	55.93
5 - 93Q3		1.53	2.9	714.4	93.96	86.1	55.93
5 - 93Q4		1.53	2.9	714.4	93.96	86.1	55.93
5 - 94Q1		1.41	3.97	726.94	93.38	95.51	50.63
5 - 94Q2		1.41	3.97	726.94	93.38	95.51	50.63
5 - 94Q3		1.41	3.97	726.94	93.38	95.51	50.63
5 - 94Q4		1.41	3.97	726.94	93.38	95.51	50.63
5 - 95Q1		1.47	4.64	745.34	93.82	88.31	50.25
5 - 95Q2		1.47	4.64	745.34	93.82	88.31	50.25
5 - 95Q3		1.47	4.64	745.34	93.82	88.31	50.25
5 - 95Q4		1.47	4.64	745.34	93.82	88.31	50.25
5 - 96Q1		1.52	4.99	803.44	94.08	97.14	46.95
5 - 96Q2		1.52	4.99	803.44	94.08	97.14	46.95
5 - 96Q3		1.52	4.99	803.44	94.08	97.14	46.95
5 - 96Q4		1.52	4.99	803.44	94.08	97.14	46.95
5 - 97Q1		1.6	5.49	842.15	94.16	96.43	43.74
5 - 97Q2		1.6	5.49	842.15	94.16	96.43	43.74
5 - 97Q3		1.6	5.49	842.15	94.16	96.43	43.74
5 - 97Q4		1.6	5.49	842.15	94.16	96.43	43.74
5 - 98Q1		1.65	5.58	885.31	94.45	NA	41.93
5 - 98Q2		1.65	5.58	885.31	94.45	NA	41.93
5 - 98Q3		1.65	5.58	885.31	94.45	NA	41.93
5 - 98Q4		1.65	5.58	885.31	94.45	NA	41.93
5 - 99Q1		1.7	6.05	941.86	94.02	94.42	38.36
5 - 99Q2		1.7	6.05	941.86	94.02	94.42	38.36
5 - 99Q3		1.7	6.05	941.86	94.02	94.42	38.36
5 - 99Q4		1.7	6.05	941.86	94.02	94.42	38.36
5 - 00Q1		1.64	6.37	976.96	93.88	93.82	39.02
5 - 00Q2		1.64	6.37	976.96	93.88	93.82	39.02
5 - 00Q3		1.64	6.37	976.96	93.88	93.82	39.02
5 - 00Q4		1.64	6.37	976.96	93.88	93.82	39.02

5 - 01Q1		1.78	3.54	1028.77	94.22	93.97	39.81
5 - 01Q2		1.78	3.54	1028.77	94.22	93.97	39.81
5 - 01Q3		1.78	3.54	1028.77	94.22	93.97	39.81
5 - 01Q4		1.78	3.54	1028.77	94.22	93.97	39.81
5 - 02Q1		1.79	2.39	1078.95	94.87	94.79	40.99
5 - 02Q2		1.79	2.39	1078.95	94.87	94.79	40.99
5 - 02Q3		1.79	2.39	1078.95	94.87	94.79	40.99
5 - 02Q4		1.79	2.39	1078.95	94.87	94.79	40.99
5 - 03Q1		1.8	3.19	1146.64	94.97	95.33	46.18
5 - 03Q2		1.8	3.19	1146.64	94.97	95.33	46.18
5 - 03Q3		1.8	3.19	1146.64	94.97	95.33	46.18
5 - 03Q4		1.8	3.19	1146.64	94.97	95.33	46.18
5 - 04Q1		1.92	4.09	1190.27	96.82	95.71	57.82
5 - 04Q2		1.92	4.09	1190.27	96.82	95.71	57.82
5 - 04Q3		1.92	4.09	1190.27	96.82	95.71	57.82
5 - 04Q4		1.92	4.09	1190.27	96.82	95.71	57.82
5 - 05Q1		2.13	4.47	1261.96	96.23	95.71	62.95
5 - 05Q2		2.13	4.47	1261.96	96.23	95.71	62.95
5 - 05Q3		2.13	4.47	1261.96	96.23	95.71	62.95
5 - 05Q4		2.13	4.47	1261.96	96.23	95.71	62.95
5 - 06Q1		2.2	6.84	1333.29	96.28	97.26	61.52
5 - 06Q2		2.2	6.84	1333.29	96.28	97.26	61.52
5 - 06Q3		2.2	6.84	1333.29	96.28	97.26	61.52
5 - 06Q4		2.2	6.84	1333.29	96.28	97.26	61.52
5 - 07Q1		2.33	7.09	1424.57	96.04	98.39	65.08
5 - 07Q2		2.33	7.09	1424.57	96.04	98.39	65.08
5 - 07Q3		2.33	7.09	1424.57	96.04	98.39	65.08
5 - 07Q4		2.33	7.09	1424.57	96.04	98.39	65.08
5 - 08Q1		2.37	7.16	1470.56	96.16	NA	71.68
5 - 08Q2		2.37	7.16	1470.56	96.16	NA	71.68
5 - 08Q3		2.37	7.16	1470.56	96.16	NA	71.68
5 - 08Q4		2.37	7.16	1470.56	96.16	NA	71.68
5 - 09Q1		2.41	4.67	1537.26	96.4	101.38	56.55
5 - 09Q2		2.41	4.67	1537.26	96.4	101.38	56.55
5 - 09Q3		2.41	4.67	1537.26	96.4	101.38	56.55
5 - 09Q4		2.41	4.67	1537.26	96.4	101.38	56.55
5 - 10Q1		2.37	5.15	1576.04	97.21	102.29	47.94
5 - 10Q2		2.37	5.15	1576.04	97.21	102.29	47.94
5 - 10Q3		2.37	5.15	1576.04	97.21	102.29	47.94
5 - 10Q4		2.37	5.15	1576.04	97.21	102.29	47.94
5 - 11Q1		2.39	1.76	1685.82	96.79	99.18	45.26
5 - 11Q2		2.39	1.76	1685.82	96.79	99.18	45.26
5 - 11Q3		2.39	1.76	1685.82	96.79	99.18	45.26
5 - 11Q4		2.39	1.76	1685.82	96.79	99.18	45.26

5 - 12Q1		2.46	2.23	1685.47	96.82	104.78	40.71
5 - 12Q2		2.46	2.23	1685.47	96.82	104.78	40.71
5 - 12Q3		2.46	2.23	1685.47	96.82	104.78	40.71
5 - 12Q4		2.46	2.23	1685.47	96.82	104.78	40.71
5 - 13Q1		2.38	2.19	1684.91	98.46	105.09	40.37
5 - 13Q2		2.38	2.19	1684.91	98.46	105.09	40.37
5 - 13Q3		2.38	2.19	1684.91	98.46	105.09	40.37
5 - 13Q4		2.38	2.19	1684.91	98.46	105.09	40.37
5 - 14Q1		2.4	2.92	1683.21	97.93	103.87	36.92
5 - 14Q2		2.4	2.92	1683.21	97.93	103.87	36.92
5 - 14Q3		2.4	2.92	1683.21	97.93	103.87	36.92
5 - 14Q4		2.4	2.92	1683.21	97.93	103.87	36.92
5 - 15Q1		2.44	4.37	1684.06	98.19	NA	34.85
5 - 15Q2		2.44	4.37	1684.06	98.19	NA	34.85
5 - 15Q3		2.44	4.37	1684.06	98.19	NA	34.85
5 - 15Q4		2.44	4.37	1684.06	98.19	NA	34.85
5 - 16Q1		2.48	4.35	1683.64	98.06	105.39	30.25
5 - 16Q2		2.48	4.35	1683.64	98.06	105.39	30.25
5 - 16Q3		2.48	4.35	1683.64	98.06	105.39	30.25
5 - 16Q4		2.48	4.35	1683.64	98.06	105.39	30.25
5 - 17Q1		2.47	4.18	1683.85	98.13	106.13	45.13
5 - 17Q2		2.47	4.18	1683.85	98.13	106.13	45.13
5 - 17Q3		2.47	4.18	1683.85	98.13	106.13	45.13
5 - 17Q4		2.47	4.18	1683.85	98.13	106.13	45.13
5 - 18Q1		2.5	5.31	1683.74	98.09	106.28	48.28
5 - 18Q2		2.5	5.31	1683.74	98.09	106.28	48.28
5 - 18Q3		2.5	5.31	1683.74	98.09	106.28	48.28
5 - 18Q4		2.5	5.31	1683.74	98.09	106.28	48.28
5 - 19Q1		2.49	4.75	1683.8	98.11	106.21	46.7
5 - 19Q2		2.49	4.75	1683.8	98.11	106.21	46.7
5 - 19Q3		2.49	4.75	1683.8	98.11	106.21	46.7
5 - 19Q4		2.49	4.75	1683.8	98.11	106.21	46.7
5 - 20Q1		2.5	5.03	1683.77	98.1	106.25	47.49
5 - 20Q2		2.5	5.03	1683.77	98.1	106.25	47.49
5 - 20Q3		2.5	5.03	1683.77	98.1	106.25	47.49
5 - 20Q4		2.5	5.03	1683.77	98.1	106.25	47.49
5 - 21Q1		2.04	10.01	382	89.16	69.34	73.38
5 - 21Q2		2.04	10.01	382	89.16	69.34	73.38
5 - 21Q3		2.04	10.01	382	89.16	69.34	73.38
5 - 21Q4		2.04	10.01	382	89.16	69.34	73.38
5 - 22Q1		2.15	7.35	418.04	90.44	70.33	74.46
5 - 22Q2		2.15	7.35	418.04	90.44	70.33	74.46
5 - 22Q3		2.15	7.35	418.04	90.44	70.33	74.46
5 - 22Q4		2.15	7.35	418.04	90.44	70.33	74.46

5 - 23Q1		2.24	9.91	458.09	90.92	72.35	74.26
5 - 23Q2		2.24	9.91	458.09	90.92	72.35	74.26
5 - 23Q3		2.24	9.91	458.09	90.92	72.35	74.26
5 – 23Q4		2.24	9.91	458.09		72.35	74.26