Insurance Sector Development, Carbon Footprint and Economic Growth in Selected Sub-Saharan African Countries

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BEING A DISSERTATION WRITTEN IN THE DEPARTMENT OF FINANCE AND SUBMITTED TO THE COLLEGE OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIIREMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE (Ph.D FINANCE), FACULTY OF MANAGEMENT SCIENCES, UNIVERSITY OF BENIN BENIN CITY NIGERIA

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DECLARATION

I, Imoseme Marian IZEDOMI, do hereby declare that this Dissertation is entirely my own work and composition. The work embodied in this dissertation has not been submitted in candidature for any degree and is not concurrently being submitted for any other degree. All references made to works of other persons have been duly acknowledged.

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CERTIFICATION OF DISSERTATION

We certify that this dissertation was carried out by Miss Imoseme Marian IZEDOMI and submitted to the Department of Finance, University of Benin, Benin City, Nigeria.

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CERTIFICATION OF DISSERTATION ON ANTI- PLAGIARISM

We the undersigned attest and declare that the dissertation of Miss Imoseme Marian IZEDOMI titled **"Insurance Sector Development, Carbon Footprint and Economic Growth in Selected Sub - Saharan African Countries"** has successfully passed the anti- plagiarism test and does not violate any copyright regulations, according to the report presented by the candidate.

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ATTESTATION

We, the undersigned attest that **Imoseme Marian IZEDOMI** has successfully carried out all the correction as recommended by the external and internal examiners in her dissertation titled : Insurance Sector Development, Carbon Footprint and Economic Growth in Sub - Saharan African Countries.

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DEDICATION

This work is dedicated pre-eminently to the creator, Almighty God the substance of my life.

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TABLE OF CONTENTS

CHAPTER TWO: LITERATURE REVIEW

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The place of the insurance industry in modern financial markets has become more significant, especially in sub-Saharan African (SSA) countries. This central role of the insurance sector has heightened evaluations of how the sector interplays with other aspects of the economy, especially in the drive for sustainable development. In this study the relative effects of insurance sector development and carbon emissions on economic growth in SSA is examined. The study focuses on the roles of different insurance sector factors and how these factors explain the effects of carbon emissions on economic growth in the region. On this basis, the study also assessed the existence of the Environmental Kuznets Curve (EKC) hypothesis for SSA countries and the directionp of causality among the environmental, economic and insurance variables.

Insurance development is measured as insurance penetration, insurance density, and insurance premium size, while carbon emission is measured by the tons of CO_2 emissions and augmented by greenhouse gas emissions. A panel of nineteen (19) selected SSA countries is employed in the study for the period 2000 to 2023. The study also evaluated the underlying dynamic interactions between insurance and the economy. Hence, the Pooled Mean Group (PMG) estimation technique is used in the empirical analysis to estimate the long-run and short-run relationship amongst the variables for the panel analysis.

The study finds that while insurance penetration and density significantly improve economic growth in the long run, the positive effect of gross premium payment is found to be only evident in the short run. There is also evidence that the Environmental Kuznets Curve hypothesis (EKC) exists for the selected Sub-Saharan African countries. In the same vein, while insurance sector development is found to significantly moderate the relationship between carbon footprint and economic growth, granger causality is shown to exist only from economic growth to insurance sector development in SSA. The findings from the study imply that insurance sector development directly improves economic growth in SSA and indirectly promotes growth by mitigating climate change effects. It is therefore recommended that insurance take-up needs to be prioritized by policy makers in SSA by deepening green insurance policies in the long run.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The insurance industry's increasing proportion of the overall financial sector in nearly all developed and developing nations has drawn attention to the relationship between insurance and economic growth. In both developed and developing nations, the insurance industry helps to mitigate business risks caused by unexpected and catastrophic events, acts as a financial intermediary through capital formation, and provides business funding for areas of the economy that are experiencing deficits (Etale, 2019). Since insurance firms cover corporate losses and prevent economic collapse, their significance for both individuals and corporations becomes increasingly clear. In addition to preventing losses, insurers also boost employment, lessen fear and anxiety, and create premiums for long-term investments, all of which have positive economic and social effects. A well-developed and evolved insurance industry is a critical condition for economic growth as it provides long term funds for long term investment and at the same time strengthens the risk-taking ability of the country (Kazeem, 2015).

Similar to banks and the capital market, insurance provides financial intermediation services to individual households and corporate units. An important component of the financial industry is insurance. The insurance industry contributes significantly to the economy of developed markets. Insurance is able to draw together, unlike other organizations, a sizable pool of money that may be invested in both short- and long-term periods by collecting relative premiums from numerous persons in the economy. Because insurers may be able to provide long-term funding, the industry is crucial for long-term economic growth. This will in turn deepen and broaden the domestic services, and generate higher saving rate and therefore greater economic growth and development (Akanro, 2008). The capacity of the sub-Saharan African area to expand, develops, and offers its residents dependable risk coverage depends on insurance. Insurance provides stability by allowing large and small businesses in sub-Saharan African countries to operate with a lesser risk of volatility or failure (Akinlo & Apanisile, 2014).

Carbon footprint is basically the total amount of greenhouse gas emissions (GHGs) particularly, carbon dioxide (CO_2) emissions that anything – a person, organization, event or product – has produced. Greenhouse gases are the gases in the atmosphere that produce the "greenhouse effect" and contribute to global warming and climate change (Wackernagel, 2008; Omoruyi - Aigbovo & Aigbovo, 2022). The emissions of GHGs particularly, carbon dioxide have been identified to constitute a greater share of the causes of global warming and climate change. Reducing carbon footprints and global warming has become a global concern as emissions generated in any one organisation or country contribute to the global problems caused by greenhouse gas (GHG) emissions. Hence, both developed and developing climes must work together in achieving the minimum carbon emissions required to sustain the climate and environmental needs (UNFCCC, 2021b).

The sub-Saharan African region is home to 1.1 billion people, which is 14% of the global population. Yet it has contributed just 0.6% of emissions. That is less than Belgium. The data is clear: Sub-Saharan has contributed almost nothing to the problem of climate change, yet it is one of the most vulnerable regions to its impacts (United Nation Environmental Programme, 2023). Thus, the African continent and indeed the sub-Saharan African region, is argued to be the most vulnerable region in the world to climate change as the region is being exposed to extreme weather conditions such as storms, ecological degradation, rise in average temperature and fluctuations in rainfall patterns, excessive rainfall, poor agricultural production, food and water insecurity, threats to human health and safety among other, thereby, leading to decrease in sustainable growth and development in the region (Kotir, 2011; Bruckner, 2012; Ibe & Amikuzuno, 2019; World Meteorological Organisation, 2023).

To tackle the problem of climate change, it has been argued that there is the need to reduce the emission of greenhouse gases otherwise long-run economic growth and national security will be adversely affected (The White House, 2016). Climate change or global warming imposes direct impacts on insurance industry and these direct impacts are increasing premium rates, shifting additional risks to policy holders through higher deductibles and lack of insurance availability from the private sector for those living in the risky geographical zone (Ahmed, Siwar & Sarkar, 2013).

The risk generated by the rising level of carbon footprints which is generally believed by scientists to have engendered global warming and climate change, has stimulated the responsiveness of various stakeholders in the insurance sector at the international, regional and national levels on how to reduce the additional risks to policy holder and also solve the inability of underwriter to measure, predict and apportion risks imposed by the rising level of carbon footprint (Omoruyi-Aigbovo & Osamwonyi, 2022). The most obvious impact of climate change in the insurance sector will be the increase in insured property losses from extreme weather events. However, there are also significant implications for asset management, as well as general issues relating to resource management (The Intergovernmental Panel on Climate Change - IPCC, 1996).

In the context of the link between carbon footprint and economic growth it has been studied and discussed in Environmental Kuznets Curve (EKC) which is also known as the EKC hypothesis originated by Kuznets (1955) when he studied the income inequality nexus. EKC postulated that the environment – growth nexus is inverted and U-shaped in nature. At the start or earliest stage of development, carbon footprint increases but after reaching certain point (turning point), emissions of carbon footprint decrease with the increase in growth. Hence countries adopt three types of strategies to control GHG emissions. They can reduce their production (Scale effect), move to cleaner/greener technologies (Technique effect), and swapping to cleaner sectors of production (Composition effect) (Grossman & Krueger, 1995).

The foregoing motivates this research which specifically, investigates how insurance sector development (insurance penetration, insurance density and gross premium) and carbon footprint (carbon dioxide (CO_2) emissions and aggregate greenhouse gas emissions) affect economic expansion in a selected nations in Sub-Saharan African Countries.

1.2 Statement of the Research Problem

The insurance industry forms an integral part of a country's financial sector and its benefits cannot be over-emphasized. Insurance sector plays an important role in economic growth by mitigating business risks occasioned by sudden and devastating occurrences in both developed and developing economies. In view of the importance or role of insurance in the growth process, several empirical studies have been undertaken on its impact on economic growth. However, no consensus has emerged on the impact of insurance sector development on economic growth.

For instance, studies such as Ćurak, Loncar and Poposki (2009); Haiss and Sumegi (2008); Arena (2008); Marijuana, Sandra and Lime (2009); Njegomir and Stojic (2010); Pen-Fen, Chen and Chen (2011) and UI-Din, Abubakar and Regupathi (2017) found that insurance sector development had positive and significant impact on economic growth. However, study by Webb, Grace and Skipper (2002); Omoke (2012) and Omoruyi-Aigbovo and Orobator (2023) showed that insurance sector development had no significant effect on economic growth. The findings of earlier research are likewise conflicting with regard to the connection between carbon footprint and economic growth which has been studied and discussed in Environmental Kuznets Curve (EKC) which is also known as the EKC hypothesis. Some studies confirmed the EKC hypothesis with an inverted U-shaped relationship between economic growth and carbon footprint (Alam, Murad & Nomanc, 2016; Al-Mulali & Ozturk, 2016; Kwakwa & Adu, 2016; Sinha & Sen, 2016; Sinha & Shahbaz, 2018; Dong, Sun & Li 2018). In contrast, other studies reported non-existence of EKC, arguing that increase economic growth reduces carbon footprint (Onafowora & Owoye, 2014; Nassani, Aldakhil & Abro, 2017; Pal & Mitra, 2017; Sinha, Shahbaz & Balsalobre–Lorente, 2017; Balsalobre-Lorente, Shahbaz, Roubaud & Farhani, 2018).

These different findings could be attributed to difference in variables used, technique in measurement of variables, scope adopted, and difference in estimation techniques employed in their studies. All these could be responsible for these mixed findings. Thus, there is need for more studies in this area to reconcile these differences and utilize recent data to investigate the effect of insurance sector development and carbon footprint on economic growth in the context of sub-Saharan African countries.

Apart from mixed findings that exist among prior studies in the literature on the foregoing discourse, methodological gap of studies in this discourse that used the Mean Group (MG) and the Pooled Mean Group (PMG) technique that allows for a higher degree of parameter heterogeneity in regressions than the other estimators is very scarce or not in existence in the sub-Saharan African countries context to the best of the researcher's knowledge. Hence, unlike previous studies on this subject matter, this study overcome the problem of parameter heterogeneity as it will employ the Mean Group (MG) and the Pooled Mean Group (PMG) estimation technique to examine the long-run and short-run nexus amongst the variables and contributes to extant literature new empirical evidence on the influence of insurance sector development and carbon footprint on economic growth in Sub-Saharan African countries.

Also, there are several empirical studies which focus on relationship between financial development and economic growth in sub-Saharan African countries, however, majority of these studies focus on the relationship between stock market development and economic growth or banking sector development and economic growth. On the contrary, there is dearth of studies that examine the impact of insurance sector development on economic growth in sub-Saharan African countries when compared to that of stock market development and economic growth or banking sector development and economic growth. The number of empirical studies on the link between insurance sector development and economic growth is relatively few for sub-Saharan African countries probably due to the small size of the sector before the reforms in the early 80s. Indeed, most existing studies on insurance-growth nexus have focused on the developed countries of Western Europe as well as emerging Asian markets. This is no doubt a gap in the literature which needs to be filled. Hence, this study attempts to fill this gap in knowledge by adding to the few empirical studies that investigate the insurance-growth nexus in sub-Saharan African countries using the most recent data.

A number of studies have been carried out to analyse the effect of insurance sector development on economic growth (Njegomir & Stojic, 2010; Pen-Fen, Chen & Chen, 2011; UI-Din, Abubakar & Regupathi, 2017; & Omoruyi-Aigbovo & Orobator, 2023 among others) as well as effect of carbon footprint on economic growth (Pal & Mitra, 2017; Sinha, et el., 2017; Aboagye, 2017; Sinha & Shahbaz, 2018; Dong, Sun & Li 2018; Balsalobre-Lorente, et al., 2018 among others), it was observed from the survey of extant literature that studies that have examine the moderating influence of insurance sector development on the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries is very scarce or not in existence to the best of researcher's knowledge. Hence, the moderating influence of insurance sector development on the relationship between carbon footprint and economic growth is largely unexplored in previous studies. Hence this study provided a new dimension that includes insurance sector development in relation to carbon footprint and economic growth in sub-Saharan African countries.

Against this backdrop, this study investigates the effects of insurance sector development and carbon footprint on economic growth in sub-Saharan Africa countries, employing the Mean Group (MG) and the Pooled Mean Group (PMG) estimation technique estimator which is more appropriate for panel data models, but absent in majority of the previous works on this discourse.

1.3 Research Questions

Based on the established research problems, the following research questions are drawn out to pilot this study.

1. What is the effect of insurance penetration on economic growth in selected Sub-Saharan African countries?
2. How does insurance density affect economic growth in selected Sub-Saharan African countries?

3. To what extent does gross premium affect economic growth in selected Sub-Saharan African countries?

4. To what extent does the environmental Kuznets curve hypothesis (EKC) exist in the selected Sub-Saharan African countries?

5. What is the moderating effect of insurance sector development variables on the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries?

6. What is the direction of causation between insurance sector development and economic growth and as well as between carbon footprint and economic growth in selected Sub-Saharan African countries?

1.4 Objectives of the Study

The central objective of this study was to empirically investigate the effect of insurance sector development and carbon footprint on economic growth in selected Sub-Saharan African countries. The particular objectives include to;

1. determine the effect of insurance penetration on economic growth in the selected Sub-Saharan African countries;

2. ascertain the effect of insurance density on economic growth in the selected Sub-Saharan African countries;

3. determine the extent to which gross premium affect economic growth in selected Sub-Saharan African countries;

4. ascertain the existence of the environmental Kuznets curve hypothesis (EKC) for the selected Sub-Saharan African countries;

5. examine the moderating influence of insurance sector development variables on the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries; and
6. determine the direction of causation between insurance sector development and economic growth as well as between carbon footprint and economic growth in the selected Sub-Saharan African countries

1.5 Hypotheses of the Study

The hypotheses of this study are stated in null form. They include;

$H0_1$: Insurance penetration has no significant effect on economic growth in selected Sub-Saharan African countries.

$H0_2$: Insurance density has no significant effect on economic growth in selected Sub-Saharan African countries.

$H0_3$: Gross premium has no significant effect on economic growth in selected Sub-Saharan African countries.

$H0_4$: The environmental Kuznets curve hypothesis (EKC) does not exist in the selected Sub-Saharan African countries.

$H0_5$: Insurance sector development does not significantly influence the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries.

$H0_6$: Insurance sector development does not Granger-cause economic growth; economic growth does not Ganger-Cause insurance sector development in the selected Sub-Saharan African countries or Carbon footprint does not Granger-cause economic growth;

economic growth does not Granger-cause carbon footprint in the selected Sub-Saharan African countries.

1.6 Scope of the Study

The study is a cross country study of the effect of insurance sector development and carbon footprint on economic growth of nineteen (19) selected sub-Saharan African countries (Angola, Benin, Botswana, Burkina Faso, Cape Verde, Cameroon, Cote d'Ivoire, Ghana, Kenya, Mauritius, Namibia, Niger, Nigeria, Senegal, South Africa, Tazania, Togo, Uganda, and Zambia). The justification for the use of the selected sub-Sahara African countries is based on regional coverage (Kenya, Uganda, and Tazania from the East Africa region; Nigeria, Ghana, Senegal, Benin, Burkina Faso, Cabo Verde, Cameroon, Cote'Ivoire, Niger and Togo from West Africa region; while Angola, Botswana, Mauritius, Namibia, South Africa and Zambia represent the South African sub-region) which gives a wider scope. Also, these countries have the highest gross premium in their respective sub-regions. The period of this study is from 2000 to 2023. The choice of this period is based on the fact that it covers the post-global financial crisis of 2007 - 2008, the era of global competitiveness amongst insurance companies in the region. Similarly, the period is somewhat relevant since most of the insurance sector reforms were introduced in the mid-1980s to 2005 and most of the extant literature did not focus on how insurance sector development and carbon footprint affect economic growth in Sub-Saharan African countries. Also, the Intergovernmental Panel on Climate Change (IPCC) completed its Second Assessment Report in 1995. The choice of the period was also based on the availability of data. The data for 2024 is not available yet, hence we stop at 2023.

1.7 Significance of the Study

The influence of insurance sector development as well as carbon footprint on economic growth has remained a contentious issue. The mixed and inconclusive nature of these previous empirical studies creates a gap for further investigation in this study in order to better understand the economic consequences of improved insurance sector and environmental deterioration in the context of Sub-Saharan Africa. This research will contribute to the extant literature by using recent data to explore the effect of insurance sector development and carbon footprint on economic growth in selected Sub-Saharan African countries thus adding new evidence to the insurance-growth debate as well as the carbon footprint-economic growth debate.

Based on the foregoing, this study will be beneficial to several stakeholders. This includes;

Government/Policy makers and Regulators: The outcome of this research will provide relevant information to policymakers in formulating appropriate policies and programmes that will positively enhance economic growth in the selected sub-Saharan African countries. Also, the outcome of this research can provide guidelines for policymakers and regulators to set better rules or revise their existing regulations. For instance, the outcome of this research can provide guidelines for policymakers and regulators to form a good environmental deprivation control policy – especially, the climate change adaptation and other environmentally related policies.

Insurance and other financial institutions: The management of insurance firms, which frequently provides insurance cover will understand how the exploitation of natural resources, which results in increased carbon dioxide emissions into the atmosphere affect economic growth, would also benefit from this study. Also, the study will enable insurance companies understand how rising carbon footprint will translates to higher payouts for insurers due to property damage, infrastructure destruction and displacement costs.

Academia: To the academia and students in management and social sciences, this study will serve as a veritable springboard and reference tool for further empirical study.

1.8 Limitations of the Study

There is no research without constraints and limitations, as they are a common phenomenon in most study and this work is not an exception. First, in carrying out this study, the researcher anticipates some limitations in data collection. The problem of inconsistency of data from different databases can pose a limitation to this study. Hence, the researcher aligned with only authorized source of data which must have been gathered with competence and expertise to enhance data integrity; hence, the data will be sourced from World Bank's Development Indicators (WDI) of 2023 and the Global Footprint Network (2023). Again the Mean Group (MG) and the Pooled Mean Group (PMG) method are not without flaws. For small T the MG and PMG are subject to the familiar downward bias on the coefficient of the lagged dependent variable. Since the bias is in the same direction for each group averaging or pooling does not reduce this bias. This problem can be mitigated by using the Kivet and Phillips (1993) bias correction estimator of the short-run coefficients, and use the corrected OLS estimators to construct the bias-corrected MG estimators of the long-run coefficients.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter addresses reviews of related literature; ranging from conceptual literature and framework, preceding theoretical and empirical literatures, as well as stating the possible gaps emanating from literature covered herein. A table that summarizes the reviewed empirical literature is also provided.

2.2 Conceptual Review

2.2.1 Concept of Economic Growth

Todara and Smith (2006) define economic growth as a steady process by which the productive capacity of the economy is increased overtime to bring rising levels of national output and income. Jhingan, (2007) defined as a steady rise in the level of per capita income followed by growth in labour force, consumption, capital and trade volume. Olowofeso, Adeleke and Udoji (2015) define economic growth as the improvement in the economic conditions of an economy. It is the continuous increase in the productive capacity of an economy and the ability to satisfy demand for goods and services, resulting from increased innovation and production scale over a particular period of time. Economic growth is the increase in the volume of production in a particular country in a given year (Ivic, 2015). Bakong (2015) similarly defines economic growth as the increase in the capacity of the economy to produce goods and services from one period of time to another. This exists when the productive capacity of a country increase. Based on the fact that economic growth measures total production for a country. It therefore, connotes the market value of all the final goods and services including personal consumption, government purchases, and private inventories paid in construction costs and their foreign trade balance.

Economic growth may be measured by real GDP, GDP per capita, GDP growth rate, gross national product (GNP), to mention but a few. GDP reflects the monetary worth of goods and services that a country produces less the worth of the goods and services consumed during production in a defined time period such as annual, semi-annual or quarterly periods. Real GDP shows the changes in GDP after inflation has been removed. Real GDP growth can be defined as the growth in nominal GDP less inflation Real GDP annual growth (%) measures the comparative health of an economy over a given period of time or the economic performance of a country which is caused by the annual economic percentage growth from one year to the next one. The standard of living of a people is measured by the GDP per capita (GDPPC) which is the ratio of real GDP to the total population of that place (King & Levine, 1993). Economic growth, which is the dependent variable in this study, will be represented by real gross domestic product which is better at explaining the wellness of the economy than other measures of the economy.

2.2.2 Concept of Insurance Sector Development

Insurance sector development refers to a process that marks improvements in the quantity, quality and efficiency of the insurance sector. It entails the growth, improvement and progression of the insurance sector. The development of insurance sector covers regulatory framework, technological advancement, product innovation, market innovation and the entire industry efficiency (Rudra, Sahar & Marepalli, 2014). In this study, insurance penetration rate, insurance density and insurance premium are the metrics used to gauge how well the insurance sector is developed.

2.2.3 Indicators of Insurance Sector Development

The indicators of insurance sector development are variables that reveal the size, structure and efficiency of the insurance sector. To measure the effects of insurance sector development on economic growth requires variables that reveal the activities of the insurance sector development and these variables are the indicators of insurance sector development. Insurance penetration rate, insurance density and insurance premium are the indicators of insurance sector development selected for this study.

2.2.3.1 Insurance Penetration Rate: Insurance penetration measures the contribution of insurance premium to the Gross Domestic Product (GDP) of a country in percentage terms. Insurance penetration rate is defined as a country's total insurance premiums as a percentage of its gross domestic product (GDP) and indicates how much the insurance sector contributes to the national economy (International Association of Insurance Supervisors, 2017)**.** Insurance Penetration rate indicates the level of development of insurance sector in a country.

Okonkwo and Eche (2019) define insurance penetration rate as a measure of the level of development of the insurance sector in a country; and is measured by the amount of insurance premium in a country as ratio of GDP. Insurance penetration rate is measured as the ratio of premium underwritten in a particular year to the GDP. Within insurance, there is life insurance penetration which considers premiums from life insurance policies only as a percentage of GDP and non-life insurance penetration which considers premium from other than life insurance policies like auto insurance, health insurance, etc. (The Economic Times, 2020). In the view of

Olarewaju and Thabiso (2021), insurance penetration infers the contribution of the insurance sector to the Gross Domestic Products. The higher the penetration rate, the more developed the insurance market (Alhassan, & Fiador, 2014). In other words, insurance penetration rate measures the growth of insurance premium in relation to the growth in the GDP.

2.2.3.2 Insurance Density: Insurance density, along with insurance penetration, is a key measure used to assess the level of development of a country's insurance sector. It is the ratio of premiums collected by insurance companies to the country's population. In other words, it is the per capital premium for the country, calculated by dividing the total insurance premium by the population. It gives an indication of how much each of the people in a country spends on insurance in terms of premium. Insurance Density may be described as the size or number of people living a particular society or geographical location. It is the concentration of people or things within an area with regards to size (Agbo & Agbaji, 2020).

Insurance density is the ratio of insurance premium to the total population. Insurance density is calculated as the ratio of total written premium within a specified time to total defined population. The population may be categorized according to: geographical location; entire nation, state; gender; age interval among others. In this case we are looking at the nation called Nigeria. Insurance density gives an insight of how much the people consume insurance. The premium accumulated over a defined period is divided by a defined population and it is usually expressed as a ratio. Insurance density represents the level of insurance market share which reflects the level of insurance performance within a given population (Omoke, 2012).

2.2.3.3 Gross Premium: The insurance premium is the price a person pays for insurance protection. It is the price payable by the insured's to the insurers for the financial guarantees

(Okonkwo, 2002). The amount of premium charged for an insurance cover is expected to make economic sense. In other words, it should be high enough to cover future claims on the pool of risks and expenses including commissions to the insurance intermediaries while still making a profit. It ought to be an amount the insured is willing to pay and must be substantially below the sum insured (Okonkwo, 2012). The insurance premium or gross written premium is the amount of money charged by the insurer or paid by the insured to secure the services of the insurance (Vaughan & Vaughan, 2014). According to Garba and Abdulsalam (2018) premium is the rate that is charged to the insured, according to his or her expectations of loss or risk. In this study, the premium income is measured as the gross premium income of all the classes of insurance underwritten by the insurance company. Gross premium is the total premium of an insurance contract before brokerage and discount is deducted.

2.2.4 Insurance Defined

Lowe (1999) defined insurance as a contract in which the risk of the insured transfer of potential loss to the insurer who promises to compensate the former upon suffering a loss. The insured then pay an agreed fee called a premium in consideration for this promise. The promisor is called the insurer and the promisee is called the insured. Agbaje (2005) defined insurance as the business function that concerns pooling resources together to pay compensation to the insured or assured on the happening to the insured in return for a premium. Vaughan and Vaughan (2008) defined insurance as a mechanism of transferring risk whereby individuals or corporates bodies shift some life uncertainties to other business enterprises' shoulders and in return pay premiums for the risk transfer.

Macedo (2009) define insurance underwriting as the process of selecting and accepting risks that behave similarly or assessing the necessary acceptance conditions to those risks that differ to maintain the homogeneity of the portfolio. Pareto (2010) defines insurance as a type of risk management in which the protected exchanges the expense of potential misfortune known as the premium to another entity in return for money related remuneration. Hughes (2013) defines insurance as the equitable transfer of the risk of a loss, from one entity to another, in exchange for regular payments. In other words, in exchange for regular payments from the insured (premiums), an insurer will commit to compensate the policyholder upon the occurrence of a specific predefined event.

These definitions support the fact that insurance is an agreement entered into by both the insurer and the insured that in the event of the latter having suffered a loss, the former will indemnify the insured in return for a price that is premium. The insurer refers to the party that agrees to pay money in the happening of the contingency. Insurers are usually the insurance companies while the insured the person who faces a particular risk. The insured seeks protection against risk by paying a premium and claims money as compensation in the event of a loss. It can therefore be concluded that insurance is a risk transfer mechanism with the misfortunes of a few borne by many in return for a price. The insurance business is usually divided into two main classes, namely: General insurance business and Life assurance business.

General Insurance Business is a contract between an insurer and the insured whereby the insurer undertakes to indemnify the assured against losses, which may result from the occurrence of specified events within specified periods. In other words, insurance contracts that do not come under the ambit of life insurance are called general insurance. General insurance is also known as non-life insurance or property and casualty insurance. General insurance business can be sub-divided into automobile, homeowners insurance, workers' compensation, commercial multiple peril, professional liability, fire, and allied lines, inland marine, ocean marine, accident and health, fidelity insurance, surety insurance, etc. (Reshid, 2015).

Life Assurance Business is a contract between the assurer and the assured whereby the assurer undertakes to pay benefits to the policyholder on the attainment of a specified event. Traditional life policies provide primarily death benefits, although many contracts have significant saving elements or contain living benefit clauses. Life assurance business comprises Term insurance, whole life, endowment insurance, universal life, variable life, variable universal life, individual life business, group life insurance and pension, life-contingent annuities and investment products, and accident and health (Reshid, 2015).

Flood Insurance: The rising climate change related risks, such as sea level rise, floods and windstorms, threaten the livability and affordability of the impacted areas. This is why one of the more widely used forms of climate risk insurance is flood insurance, which provides coverage against loss caused by flooding (Aon Environmental Edge, 2023).

Environmental Insurance: Environmental insurance policies are designed to address the various financial losses that can occur from a pollution or contamination incident. These can include: Compensation to third parties for injury and property damage, clean-up costs, including third-party claims and statutory clean-up notices, civil fines and penalties, legal defense costs, natural resource damages and emergency response cost. More recently, we have seen organizations looking at environmental insurance with a fresh perspective as they consider how insurance products may complement their objectives related to environmental, social and governance (ESG) issues and in response to climate-related risks and losses (Aon Environmental Edge, 2023).

2.2.5 Carbon Footprint

Carbon footprint concept was discovered in 1990 by William Rees and Mathis Wackernagel in British Columbia University out of the ancients' concept of ecological footprint. This encompasses the total land dimension required for population or other activity sustenance. CO_2 emission is often measured in weight of tons or its equivalent yearly (Selin, 2020). A carbon footprint may be defined as a measure of the quantity of carbon dioxide released into the atmosphere due to fossil fuels combustion, or the fossil fuel energy embodied in a commodity or product reaching market, or the quantity of carbon dioxide emitted by a business outfit either directly or indirectly due to its daily operations (Grubb & Ellis, 2007). A carbon footprint is also defined as the total amount or set of carbon dioxide emissions generated directly and indirectly by an activity or that is accumulated over the life-cycle of goods and services of an event, individual, organisation or government (Wiedmann & Minx, 2008; Carbon Trust, 2007). East (2008) defines a carbon footprint as a direct measure of GHG emissions caused by a defined activity which could include emissions emanating from activities within the ownership or control of the emitter as well as the indirect emissions emanating from the usage of purchased electricity, and expressed in tonnes of CO_2 equivalents. Carbon footprint can also be termed as a standard measure of human demand for natural capital placed on the planet but above the ecological capacity of the planet to cope with and regenerate (Gao, Liu & Wang, 2013). In this study, carbon footprint will be measured as carbon dioxide (CO_2) emissions.

2.2.5.1 Indicators of Carbon Footprint

In this study, carbon footprint will be measured as carbon dioxide (CO_2) emissions.

2.2.5.2 Carbon Dioxide (CO_2) Emissions: Carbon dioxide (CO_2) is a colorless, odorless and non-poisonous gas formed by combustion of carbon and in the respiration of living organisms and is considered a greenhouse gas. Emissions mean the discharge of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time. Carbon dioxide emissions or CO_2 emissions are emissions stemming from the burning of fossil fuels and the manufacture of cement; they include carbon dioxide produced during consumption of solid, liquid, and gas fuels as well as gas flaring (Eurostat, 2017). According to the World Bank (2018), CO_2 emissions are defined as those stemming from the burning of fossil fuels and the manufacture of cement. They comprise CO_2 produced during the consumption of liquid, solid, and gas flaring and gas fuels. Carbon emission is measured as metric tons per capita (kt)**.**

Carbon dioxide emissions is define as the volume of emission that is related to the total operation of a person, group of persons, organizations, buildings, country among others in a given period. Direct emissions from fossil fuel combustion in transportation, heating and manufacturing, greenhouses gases emissions such as nitrous oxide or chlorofluorocarbons (CFCs) and methane are all inclusive. Carbon dioxide (CO_2) is identified as the most dominant GHG in the atmosphere, it is the most prevalent greenhouse gas after water vapor and has therefore become the proxy by which greenhouse gas emissions is measured (Selin, 2020; Omoruyi-Aigbovo & Osamwonyi, 2022).

Greenhouse Gas (GHG) is any gas in the atmosphere which absorbs and re-emits heat, and thereby keeps the planet's atmosphere warmer than it otherwise would be. The main GHGs in the Earth's atmosphere are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone. GHGs occur naturally in the Earth's atmosphere, but human activities, such as the burning of fossil fuels like coal, petroleum, natural gas as well as large scale deforestation are increasing the levels of GHG's in the atmosphere, causing global warming and climate change (Mackay, 2008). The Kyoto Protocol is an international treaty for controlling the release of GHGs from human activities, and the GHGs controlled under the treaty includes; Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide(N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur hexafluoride (SF_6) and Nitrogen trifluoride (NF_3)[3]. These GHGs are often referred to as the "Kyoto gases" (Brander, 2012). Nitrogen trifluoride was included in the second Kyoto Protocol commitment period (from 2013 to either 2017 or 2020). For the first commitment period (2008 to 2012) only the first six gases were included.

Carbon dioxide (CO_2) is the most common GHG emitted by human activities, in terms of the quantity released and the total impact on global warming. As a result, the term "CO_2" is sometimes used as a shorthand expression for all greenhouse gases, however, this can cause confusion, and a more accurate way of referring to a number of GHGs collectively is to use the term "carbon dioxide equivalent" or "CO_2e" (Brander, 2012).

"Carbon dioxide equivalent" (CO_2e) is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact. A quantity of GHG can be expressed as CO_2e by multiplying the amount of the GHG by its Global Warming Potential (GWP). For example, if 1kg of methane is emitted, this can be expressed as 25kg of CO_2e (1kg CH_4 * 25 = 25kg CO_2e). "CO_2e" is a very useful term for a number of reasons: it allows "bundles" of greenhouse gases to be expressed as a single number; and it allows different bundles of GHGs to be easily compared (in terms of their total global warming impact). However, one word of caution when comparing CO_2e totals is that it is important to know that the same GHGs are included in the totals being compared, in order to be sure that like-for-like comparisons can be made. It is also worth noting that "CO_2e" is also sometimes written as "CO_2eq", "CO_2equivalent", or even "CDE", and these terms can be used interchangeably (Brander, 2012).

2.2.6 The Environmental Kuznet Curve

In the context of the association between environmental degradation and economic growth, Environmental Kuznets Curve (EKC) hypothesis is one of the extensively researched hypotheses. According to this hypothesis, environmental degradation starts at the earliest stage of economic growth, grows with the rise in income, and once the income reaches a certain point, i.e. the turnaround point, the environmental degradation starts to decline. Therefore, the generally accepted form of EKC is inverted U-shaped (Graphically, this empirical relationship takes the form of an inverted U-shape). In other words, in a country's development process, as per-capita income rises, environmental quality initially deteriorates to a certain point, after which environmental quality improves while income continues to rise (Panayotou, 2003).

It is possible to describe the structure of the EKC in terms of the process of structural change in economic growth. Early development, or the transition from a pre-industrial to an industrial economy (see Figure 2.1), is characterised by a decline in environmental quality as the proportion of agriculture declines and the proportion of industry increases. This would occur by favouring physical capital-intensive industries over those requiring human capital, which would cause a progressive increase in productivity, per capita income, and consumption. An anticipated improvement in environmental quality results from the society's transition from an industrial to a post-industrial economy, which is characterised by a fall in the share of industry and an increase in the percentage of services. This means that at the turning point (which is under industrial economies) in Figure 2.1, environmental indicators would start to display improvements (UNCTAD, 2012).

Figure 2.1 illustrates how the effects of subsistence economic activity, or agriculture, are the only sources of environmental deterioration at this early stage of development, both in terms of quantity and intensity. Waste production and resource depletion increase when industrialization takes off in tandem with increased agricultural and resource extraction. This is shown by the curve's rising slope. Later stages of development see a structural shift towards information-based services and industries, the emergence of increasingly effective technologies, and an increase in the demand for high-quality environmental products. As a result, the curve turns, and environmental deterioration gradually decreases after that (Moomaw & Unruh, 1997; Panayotou, 2003). This explains why the curve below slopes downward.

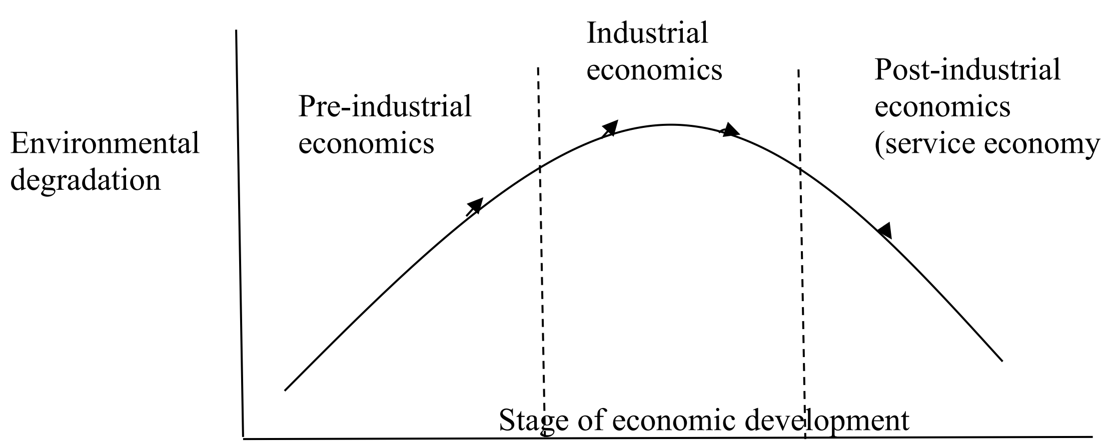


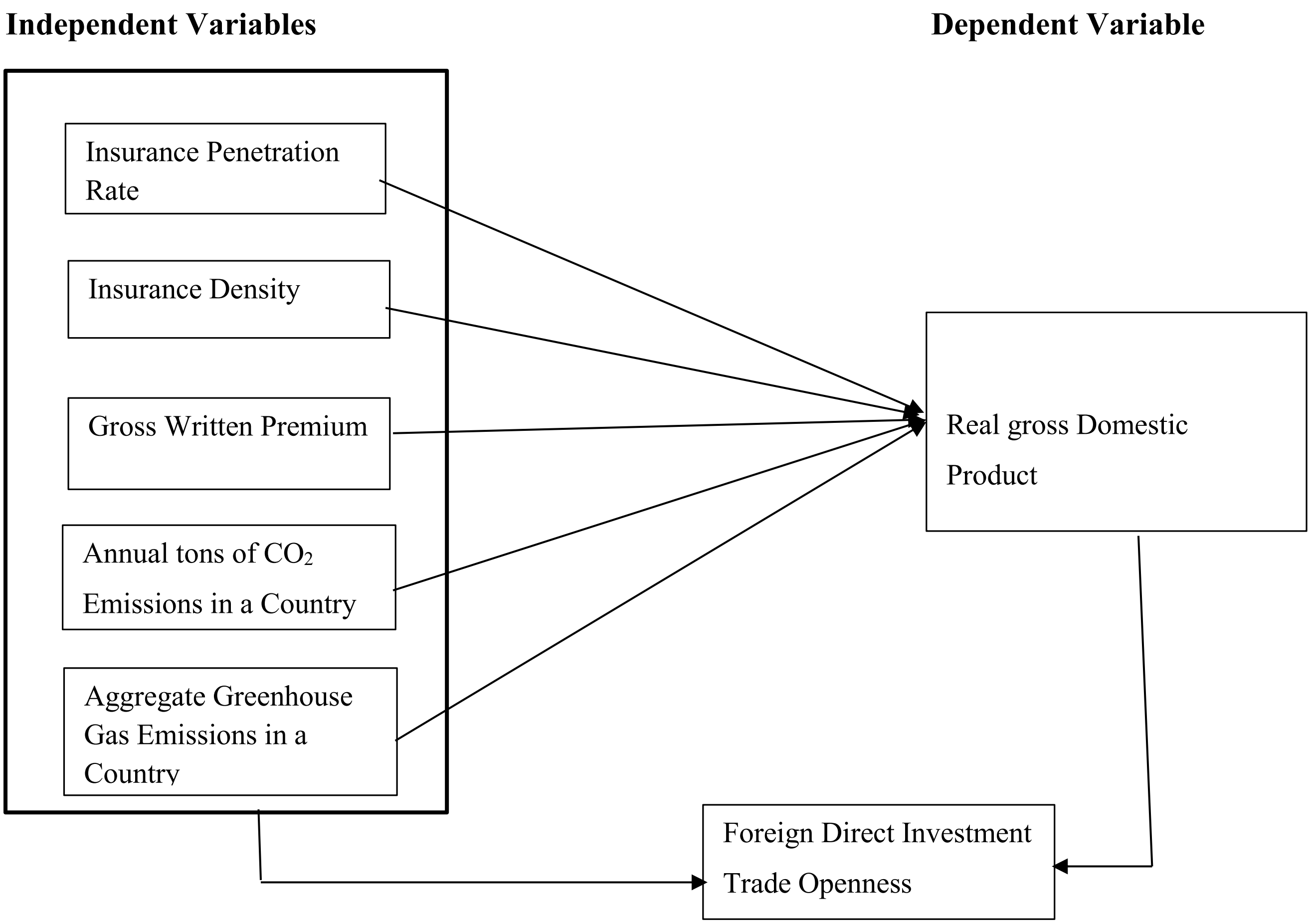
Fig. 2.1: The shape of the EKC

Notes: The horizontal axis is income per capita.

Source: Panayotou (2003:46)

2.2.7 Conceptual Framework

After review of extant literature, a conceptual framework was developed for the study which is depicted in Figure 1. The conceptual framework in figure 1 is designed to explain how each independent variable influences economic growth. The schematic representation of the relationships between the independent variables and the dependent variable is shown in Figure 1.



Source: Researcher's Construction, 2025

Figure 1: Conceptual Framework of the Study

Figure 1 shows the path of the study which is aimed at examining the impact of insurance sector development (insurance penetration rate, insurance density and gross written premium) and carbon footprint (annual tons of CO_2 emissions and aggregate greenhouse gas emissions) on economic growth in sub-Saharan African countries.

2.3 Theoretical Review

In this section, we review some theories which are related to the concept of insurance sector development, carbon footprint and economic growth. These theories include (i) neo-classical theory of economic growth (ii) circuit theory (iii) endogenous growth "AK" model and (iv) the environmental Kuznets curve (EKC) hypothesis.

2.3.1 Neo-Classical Theory of Economic Growth

The neo-classical theory and Harrod-Domar theory best explain present day economic growth behaviour in different perspectives. The neo-classical theory of economic growth was advocated by Tobin, Swan, Solow, Meade, Phelps and Johnson, and it demonstrate how a country's economic growth level can be assisted by its wealth of capital, labour supply and technological advancement over time (Solow, 1956). It is usually expressed in production function as follows:

$Y = f(Cc, Lbr, TeD)$……………………………………………………………………1

Where Y is the National output; Cc is Capital stock; Lbr is Labor supply and TeD is the Scale of technological development.

It is assumed that with constant return to scale, as national output (ΔY) rises, it will equate overall marginal productivity (MaPr) multiply by ACc and ΔLbr. Therefore,

$\Delta Y = \Delta Cc.\ MaPrk + \Delta Lbr.\ MaPrl$……………………….…………………………………….2

Where, MaPrk is marginal physical product of capital; MaPrl is the marginal physical product of capital.

Thus, dividing the national output by Y, we arrive at $\Delta Y/Y = \Delta Cc\ (MaPrk/Y) + \Delta Lbr\ (MaPrl/Y)$. The Cc. MaPrk and Lbr. MaPr is the aggregate stake of capital and labor in the national output, whereas Cc/Y* MaPrk and Lbr/Y* MaPrl stands for relative stake of capital and labour in the national output. Therefore;

$(Cc.\ MaPrk/Y) + (Lbr.\ MaPrl/Y) = 1$……………………………………………………………3

However, with respect to technological change, the change in national output is given by:

$\Delta Y/Y = b\Delta Cc/Cc + (1 - b)\ \Delta TeD/TeD$ …………………………………………………………4

The whole essence of the neo classical theory is therefore based on the assumptions that there exist a commodity and a factor market that is totally competitive in nature in such a way that its payments equate those of production extra income, coupled with a complete employment level situation (Solow, 1956).

2.3.2 Circuit Theory

Bossone (1998 and 2001), in articulating the circuit theory of finance incorporated a microeconomic dimension into the theory. The complementary roles that banks and non-banking financial intermediaries, including as insurance firms, play in creating money and ensuring that it circulates in a way that benefits all agents are essential to the circuit process. As a result, financial systems that include basic but divided money and capital market operations—like those in many emerging economies—are more vulnerable to volatility and circuit failure. Rajan and Zingales (1998) pointed out that it is the availability of investment opportunities that drive economic growth. The researchers concluded that the relationship between financial development and growth is a consequence of the theory of financial markets and institutions, which lowers the cost of external financing for businesses. They also noted that the long-term development of financial markets aided the export expansion of industries dependent on outside funding.

A sound financial structure is an engine that drives economic growth through entrepreneurship growth as noted by Schumpeter (1934). Others like Goldsmith (1955), Mckinnon (1973), and Shaw (1973), also acknowledged this view through the positive response of savings to the interest rate. Greenwood and Jovanovic (1990) established a model in which financial structure and economic performance are endogenously determined. The researchers emphasized that the financial structure might promote quicker economic growth by reducing uncertainty regarding the rate of return and pooling individual investment risk.

2.3.3 Endogenous Growth "AK" Model

In order to show the channels through which financial development affects economic growth, Pagano (1993) developed the endogenous growth "AK" model. The "AK" model of endogenous growth states that an economy produces a single good and that its total output (Y) over time (t) is determined by its total capital stock (K).

$Y_t = AK_t$ ……………………………………..…………………… (2.1)

where A is the capital's marginal production. During time t, the capital stock is

$K_t = I_{t-1} + (1-\delta)K_{t-1}$ ………………………………………………….…..(2.2) with I investment

This corresponds to non-consumed goods that lose value at a rate of δ per period. Gross saving must equal gross investment in order for the capital market to be in balance. The following funds are available for investment since the process of channeling savings to investments loses one portion of savings $(1-\varphi)$:

$\varphi S_{t-1} = I_{t-1}$ ………………………………………………………………….(2.3)

At time t, gt=(Yt/Yt-1) - 1=(Kt/Kt-1) is the growth rate g. 1. Equations (2) and (3) may be used to get the steady-state growth rate.

$g = As\varphi-\delta$ …………………………………………………………….…… (2.4)

where s stands for saving rate (S/Y).

The model illustrates three pathways from financial development to economic growth: the savings rate, the percentage of savings directed toward investments, and the marginal productivity of capital. The Schumpeterian growth models, the alternative perspective on the idea of endogenous development, concentrate on technical advancements as a potential conduit for economic expansion.

2.3.4 The Environmental Kuznets Curve (EKC) Hypothesis

The Environmental Kuznets Curve (EKC) hypothesis explains that in the initial stages of economic growth and development carbon footprint increases, but after a particular level of economic growth and development society commences to improve its relationship with the environment. This was labeled as EKC by Panayotou (1995) on the basis of Grossman and Krueger (1995) work who first pointed out the inverted U-shaped relationship between environmental pollutants and per capita income. The empirical literature largely confirms the presence of EKC in developed and developing countries (Grossman & Krueger, 1995; Majeed, 2018). The EKC hypothesis posits that, an initial stage of economic growth and development is associated with a higher level of carbon footprint and pollution until a certain stage of economic development will gradually improve environmental quality. This implies that after some turning points, economic growth may actually bring some ecological benefits (Grossman & Krueger, 1991, 1993, 1995).

The Environmental Kuznets curve (EKC) hypothesis suggests that economic growth has scale, composition and technical effects. Thus, in the early stage of growth, the use of basic and inefficient technology in production degrades and pollutes the environment (that is, scale effects). As the economy transits to industrial production, and then to the service sector, economic growth induces investment in sector that pollute less (that is, composition effect). Finally, at higher levels of economic growth there is a structural change towards more high-technology and service-oriented sector (that is, technical effect) which gradually reduce environmental degradation (Hussen, 2005).

2.4 Empirical Review

A number of empirical investigations have been carried out to find the nexus between insurance sector development and economic growth as well as between carbon footprint and economic growth on the other hand. In this section, we review some of these previous empirical studies. Reviewing the previous studies will enable the researcher to identify the gaps that might have been left for further studies. These studies are divided into two parts: insurance sector development and economic growth studies for developed countries and developing countries as well as carbon footprint and economic growth studies for developed economies and developing countries.

2.4.1 Insurance Sector Development and Economic Growth: Empirical Evidence from Developed Countries

In this section we review studies that examined the relationship between insurance sector development and economic growth in developed economies.

Beenstock, Dickinson and Khajuria (1988) applied pooled time series and cross-sectional analysis on 1970 to 1981 data, covering 12 countries. The impact of property liability insurance (PLI) premiums on GDP, income, and interest rate development was examined using a multiple regression model. The results showed that premiums are related to both GNP and interest rates, and that the marginal propensity to insure (both in the short and long term) increases with per capita income and is always higher in the long term.

Ward and Zurbruegg (2000) examined short and long dynamic relationships between economic growth, measured by annual real GDP, and insurance industry, measured by total real premiums, for nine OECD countries for the period 1961-1996. Changes in private saving rates, the general government budget surplus, population size, the general government level of current expenditure, and youth plus old age dependency ratios—which are defined as the percentage of the population under 16 and over 65—were employed as additional explanatory variables. Based on the Granger causality test using the bivariate VAR approach. The researchers discovered that different nations had different causal relationships between the development of the insurance market and economic growth. Although they expressed their thoughts that the country-specific cultural, legal, and regulatory context, the advancement of financial intermediation, and the moral hazard impact of insurance might be contributing factors, they could not pinpoint the precise causes.

Webb, Grace and Skipper (2002) examine whether banks, life and non-life insurers individually and collectively contribute to economic growth by facilitating the efficient allocation of capital using revised Solow-Swan model of economic growth. They utilize cross-country data from 1980 to 1996 for 55 rich and developing nations, omitting the economies of former communist Europe. They use average growth rate of capital stock per capita, average penetration of banking activity, average level of exports as a percentage of GDP, average government expenditure share of GDP, natural log of initial real GDP per capita, and data on the percentage of the population over 25 who have completed primary school as explanatory variables for GDP per capita growth, in addition to average penetration of life and non-life insurance. They discovered that higher productivity is strongly predicted by the exogenous factors of banking and life insurance penetration. There is synergy between banks and insurers, meaning that the combined advantages of the two organizations are more than the sum of their separate contributions. They also discovered no connection between non-life insurance and economic development. The prevalence of life insurance is impacted by economic expansion, although banking development is not predicted by it.

Kugler and Ofoghi (2005) use the components of net written insurance premium to evaluate a long run relationship between development in insurance market size and economic growth by using Johansen's λTrace and λmax co integration tests. Disaggregated data for long-term insurance includes yearly and single premium (including life insurance, annuities, individual pensions and other pensions) for the period 1966-2003 and for general business insurance, includes motor, accident and health, liability, property, pecuniary loss, reinsurance and MAT (Marine, Aviation and Transport) for the period 1971-2003. The long-term association between the size of the insurance market and economic growth was validated by cointegration tests for the majority of variables and at the 5% level of significance. The findings of causation tests indicate that, for eight of the nine markets (pecuniary loss insurance being the outlier), there is a long-term correlation between the growth of the insurance market and economic expansion rather than a cyclical influence. Short-term economic growth is fueled by increases in liability, pecuniary loss, and life insurance (both annual and single premium). They also discovered that there is a stronger causal relationship between GDP growth and the expansion of the insurance market than there is between the two.

Haiss and Sümegi (2008) conducted a panel data analysis for 29 European countries covering the period 1992–2005 to examine the impact of insurance company investments and insurance premiums on GDP growth. Their findings suggested that there were distinctions between less developed nations and those with more established financial markets. However, life insurance had a beneficial effect on real GDP growth in the EU-15, Switzerland, Norway, and Iceland markets. However, liability insurance had a greater effect in Central and Eastern European new EU member states.

Arena (2008) investigates causal relationship between insurance market activity and economic growth using the generalized method of moments for dynamic models of panel data for 55 countries, including high, middle and low income countries, for the period 1976-2004. In order to evaluate possibly disparate impacts on economic growth, as shown by increase in real GDP per capita, he utilizes statistics for both life and non-life insurance premiums. He also utilizes statistics on terms of trade changes, openness, government consumption, inflation, private credit, stock market turnover, starting GDP per capita, and human capital as explanatory factors. He discovered evidence to support the idea that insurance has a causal impact on economic growth. The study's findings, however, show that life and non-life insurance have distinct effects on economic expansion. The beneficial impact of life insurance premiums on economic growth is mostly driven by high-income nations, but the influence of non-life insurance premiums on economic growth is driven by all nations, albeit with a greater effect in high-income nations. He also discovered that at low economic development levels, life insurance would have a greater effect on economic growth than non-life insurance at intermediate levels. Lastly, he concluded that if the stock market developed more deeply, life insurance would have a greater influence on economic growth, but the results for non-life insurance point to a complementary effect for the early and intermediate phases of stock market development.

Marijuana, Sandra and Lime (2009) examined the relationship between insurance sector development and economic growth in 10 transition European Union member (2009) empirically examined the relationship between insurance sector development and economic growth in 10 transition European Union member countries in the period from 1992 to 2007. In addition to other control factors including education, openness, inflation, investment, bank credit, and stock capitalization, three distinct insurance variables were used: life, non-life, and total insurance. Their results show that the growth of the insurance industry has a favorable and considerable impact on economic expansion. In terms of overall insurance as well as life and non-life insurance, the results are validated.

Utilizing the GMM models on a dynamic panel to the data for 77 countries in the period 1994–2005 while using insurance density as a measure of insurance development, Han et al. (2010) reached the conclusion that insurance market development, as well as the development of individually observed life and non-life insurance markets, had a far more significant role for developing economies than for developed economies.

Njegomir and Stojić (2010) examine the impact of insurance on economic growth and interaction of insurance and banking in promoting economic growth in ex-Yugoslavia region. For panel data from 2004 to 2008, the researchers employ country-specific fixed effects models, which enable each cross-sectional unit to have a unique intercept term acting as an unobserved random variable that may be connected with the observed regressors. The findings of the study demonstrate that insurers have a beneficial impact on economic growth as institutional investors as well as suppliers of insurance risk management and indemnity.

To examine the causal relationship between insurance market activities and economic growth for 10 selected OECD countries during the period 1979–2006, Lee (2011) used panel unit root tests, heterogeneous panel cointegration tests and panel causality techniques in his research and concluded that there was strong evidence to support the hypothesis of a long-term equilibrium relationship between real GDP and insurance market activity, with a greater influence of the non-life insurance market in relation to the life insurance market. The use of a dynamic panel-based error correction model demonstrated that the growth of the insurance market and economic expansion are causally related in both the short and long run.

Using data from 1995 to 2010, Kjosevski (2013) employed the multiple regression technique of analysis to investigate the effect of insurance on Macedonia's economic development. It has been determined that the three independent variable indices—life, non-life, and total penetration—have a major effect on economic growth.

Chang, Lee and Chang (2013) studied the relationship between insurance and economic growth by conducting a bootstrap panel Granger causality test using data from 10 OECD countries over the period of 1979-2006. They used the premiums for life, non-life, and total insurance as standins for the operations of the insurance market. Although their findings were conflicting, they discovered that in five OECD nations—France, Japan, the Netherlands, Switzerland, and the UK—there was evidence of a one-way Granger causal relationship between insurance activity and GDP. Insurance is so crucial to these nations' economic development. Second, they discovered evidence of a one-way Granger causal relationship between GDP and insurance activities in the US (for total and non-life insurance activities), Italy (for total and life insurance activities), and Canada (for life insurance activity). This finding suggested that economic expansion might raise insurance demand, which in turn can fuel the growth of insurance markets. Third, they discovered a two-way Granger causation (feedback) between GDP and life insurance activity in the United States.

Cristea, Marcu and Carstina (2013) sought to find the causal link between the insurance and economic growth in Romania. The result of the Pearson Correlation performed indicated that there is high correlation between the insurance market and gross domestic product growth in term of causal link.

Zouhaier (2014) examined the relationship between the insurance business and the economic growth of 23 OECD countries over the period 1990 –2011. Using a static panel data model, the findings showed that non-life insurance, as indicated by the penetration rate, significantly and favorably impacted economic growth, while total insurance and non-life insurance, as indicated by the insurance density, had a detrimental effect.

In their 2017 study, Ul Din, Abu-Bakar, and Regupathi investigate the connection between insurance and economic expansion in 20 nations between 2006 and 2015. Three unique proxies—net written premiums, penetration, and density—are used to quantify insurance activity.

The fixed effect model's suitability for this dataset was validated by the Hausman statistics. For industrialized nations, the researchers discovered a strong and positive correlation between life insurance, as determined by net written premiums and insurance density, and economic growth; for underdeveloped nations, the same correlation holds true when insurance is measured using a penetration proxy. The findings also show that non-life insurance has a statistically significant link with economic growth for developing nations across all three proxies, but only when insurance density is employed as a proxy for insurance do the results hold true for wealthy nations. Furthermore, non-life insurance plays a bigger part in emerging nations than in industrialized ones.

The fact that the relationship between insurance and economic growth varied from country to country was also proved by Demirci and Zeren (2017), who investigated the relationship between insurance premiums per capita and real GDP for 13 OECD countries in the period 1983–2011. Their results indicate the existence of a causality between the insurance premium per capita and real GDP in 4 out of 13 analysed countries (France, Iceland, Italy and Spain).

Using yearly data from the European Insurance Industry database and Eurostat for the years 2004–2015, Peleckienė, Peleckis, Dudzevičiūtė, and Peleckis (2019) investigated the connection between the growth of the insurance market and economic expansion in 27 EU nations. They employed total premiums per insured to gauge the growth of the insurance market and GDP per capita as a gauge of economic progress. According to their Granger causality test (1969), Slovakia had no causal relationship between the variables, but Austria had two-way causality. The test's results demonstrated that there was a one-way causal relationship between GDP per capita and total premiums per insured in Finland and Luxembourg, as well as a one-way causal relationship between GDP per capita and total premiums per insured in the Netherlands, Malta, and Estonia.

Between 2006 and 2016, a sample of 27 OECD nations was employed by Apergis and Poufinas (2020). There was a statistically significant two-way causal relationship between economic growth and gross insurance premium (total and life insurance premium), according to the results of the Dumitrescu-Hurlin panel Granger causality test. However, there was only a one-way causal relationship between GDP and gross non-life insurance premiums.

Mirela, Miloš and Milijana (2022) examine the relationship between insurance market development and economic growth in EU member states in the period 1998-2018. The findings show that, in the case of 11 of the 23 countries examined—including four that are categorized as developing markets—there is no direct relationship between premium per capita and GDP per capita growth. Nonetheless, we found a two-way causal relationship between the expansion of the insurance market and economic growth in the case of panel data encompassing all nations. The data panel and the cases of individual nations demonstrate that, in the near term, premium per capita has a positive and considerable influence on economic development, with the exception of Ireland and Luxembourg, where the applied model simply displays error-correction coefficient values. Furthermore, our findings show that, in the cases of Belgium, Cyprus, Bulgaria, Romania, and Slovenia, premiums per capita have a major positive impact on economic growth over the long term; in other words, insurance premiums are a major factor in determining long-term economic growth. A panel study of all observed nations and emerging market countries reveals a statistically significant long-term positive link between GDP growth per capita and premium per capita. However, a long-term positive relationship—albeit one that was not statistically significant—was revealed by the panel data study of the nations that fall within the developed market category.

Dawd and Benlagha (2023) examined the effect of insurance development on economic growth in 16 OECD countries for the period 2009 to 2020. Employing the dynamic panel technique (GMM), the finding shown that insurance sector development meaningfully impacted economic growth; coupled with fact that the inverted U-shaped relationship was also confirmed in the study.

2.4.2 Insurance Sector Development and Economic Growth: Empirical Evidence from Developing Countries

This section surveys studies that studied the influence of insurance sector development and economic growth in developing economies.

Outreville (1990) conducted a study on the effect of property liability insurance premium on GDP for the year 1983 and 1984 for 55 developing countries. The outcome shows that property liability insurance has a meaningful link with GDP. Brown (2000) applied a pooled cross-sectional panel model to motor vehicle and general liability insurance in the OECD over the 1986 to 1993 periods. They examined the impact of liability insurance on a number of variables, such as wealth, income, and the judicial system. Wealth and loss likelihood have a negative correlation with insurance consumption, although income and the legal system have a positive correlation.

In Iyiola and Rechard (2007), the empirical study adopted Ordinary Least square. The result of the test revealed that gross domestic product explains for over 53% of the changes in insurance income with the value of the adjusted R^2 of 0.53. The study concluded however, that insurance did not significantly contribute to Nigeria's real gross domestic product between 1996-2012.

Omoke (2012) examine the insurance market activities in Nigeria with the view to determining its impact on economic growth. Using insurance density measurements (premium per capita) as a gauge of insurance market activity and real GDP for economic growth, the study covered the years 1970–2008. As additional growth factors, it also used control variables like inflation and savings rate. The link between the variables was estimated using vector error correction and Johansen cointegration. The results indicated a long-term link between the variables, and all of the variables employed were stationary at first difference. The outcome shows that, during the research period, the insurance industry had no discernible and beneficial impact on Nigeria's economic growth.

From 1981 to 2008, Mojekwu, Agwuegbo, and Olowokudejo (2015) investigated the role of insurance in Nigeria's economic expansion. The study's explanatory variable was the whole volume of insurance business, while the response variable was GDP, a stand-in for economic growth. They used a dynamic factor model with panel autocorrelation and sample autocorrelation functions as statistical tools for data analysis. The findings showed a favorable correlation between the insurance industry and economic expansion.

Using time series secondary data from 1997 to 2008, Ching, Kogid, and Mulok (2011) investigated the causal relationship between Malaysia's general insurance industry and economic development. The predictive variable, general insurance investment, was regressed against the response variable, real gross domestic product, which serves as a stand-in for economic growth. They used the Granger causality test, Autoregressive Distributed Lag (ARDL), and Error

Correction Model (ECM) as statistical techniques to analyze the data from their study. The findings demonstrated that the general insurance industry's total assets had a favorable impact on Malaysia's economic development.

Ming, Yung and Ting (2012) investigated the relationship between insurance demand, financial development and economic growth in Taiwan using secondary data from 1961 to 2006. The dependent variable was GDP, a stand-in for economic growth, while the explanatory variables were insurance demand and financial development. For data analysis, the study used the Vector Autoregressive (VAR) model. The demand for insurance, financial development, and GDP growth were shown to be symmetrical.

Oke (2012) examined the short and long-run relationships between economic growth and insurance sector development in the Nigerian economy. After adopting the fixed-effect model, pertinent data from 1985 to 2009 were gathered and subjected to co-integration analysis. Gross domestic product was utilized as a stand-in for economic growth, while the number of insurance firms, life and non-life insurance premiums, total insurance investment, and inflation rate were used to gauge the expansion of the insurance industry. The results showed that the expansion and development of the insurance industry has a favorable and considerable impact on economic growth.

Yinusa and Akinlo (2013) analyzed both the long- and short-run relationships between insurance development and economic growth in Nigeria over the period 1986–2010. The study's use of the error correction model (ECM) reveals a cointegration between Nigeria's economic growth and the development of insurance. The development of insurance and Nigeria's economic expansion are correlated throughout the long term. The findings also demonstrate that while physical capital and inflation have long-term negative connections with economic growth, physical capital and interest rates, both at current and one-lag values, have a considerable beneficial impact on economic growth in Nigeria. Overall, the findings show that insurance has a statistically significant impact on Nigeria's economic expansion.

Victor (2013) used multiple regression method of analysis to examine the relationship between the insurance and economic growth in Nigeria. Investments in insurance and insurance premium were employed for the independent variable. The finding of the empirical analysis show a very strong relationship is established between insurance and economic growth. From the finding, it was concluded that a viable insurance will no doubt help to grow the economy.

The effect of insurance practices on the expansion of the Nigerian economy was investigated by Eze and Okoye (2013). Insurance practice was measured using insurance premium income, total insurance investment, and insurance development income. For data analysis, the study used the Johansen co-integration test, unit root tests, and error correction model. The study found that there is a causal relationship between the development of the insurance sector and economic growth in Nigeria, that the capital of insurance premiums has had a significant impact on economic growth in Nigeria, and that the amount of total insurance investment has had a significant impact on economic growth in Nigeria.

Likewise, Chau, Khin and Teng (2013) investigated the link between life and general insurance consumption and economic growth in Malaysia using secondary data from 1970 to 2012. The independent variables included in the study were capital stock, total employment, life insurance premiums, and general insurance premiums, all of which were regressed against GDP, a measure of economic progress. As statistical techniques for data analysis, they used the Granger causality test, unit root test, co-integration test, and Error Correction Method (ECM). Their results demonstrated that whereas capital stock and general insurance had a long-term positive substantial influence on economic growth, total employment and life insurance premiums had a short-term significant positive impact.

Sibindi and Godi (2014) investigate the causal relationship between the insurance sector (long-term, short-term and total insurance) and economic growth in South Africa for the period 1990 to 2012. They used real per capita growth domestic product as a stand-in for economic growth and insurance density as a stand-in for the expansion of the insurance market. After using the Johansen approach to test for cointegration among the variables, the researchers use the vector error correction model (VECM) to test for Granger causality. The findings support the presence of at least one cointegrating link and show that causation flows both from the economy to the long-term insurance market and from the economy to the insurance industry as a whole.

From 2000 to 2011, Madukwe and Obi-Nweke (2014) investigated the relationship between Nigeria's overall insurance industry and economic expansion. Pearson's Product Movement correlation approach was used to regress GDP, the dependent variable, against the total insurance business, the independent variable, which served as a stand-in for economic growth. The findings showed that the insurance industry and economic expansion were strongly positively correlated.

Additionally, from 2000 to 2011, Madukwe and Anyanwaokoro (2014) examined the connection between Nigeria's economic development and the life insurance industry. Their analysis used Pearson's Product Movement correlation approach to regress GDP, a proxy for economic growth, on life insurance premiums. Individuals and corporate entities in Nigeria did not exhibit much interest in the life insurance industry, despite the regression findings indicating a substantial correlation between GDP and life insurance premiums.

Alhassan and Fiador (2014) examined the long-run causal relationship between insurance penetration and economic growth for Ghana during the period of 1990–2010. The autoregressive distributed lag (ARDL) limits technique was employed by the authors. Aggregate insurance penetration and growth, as well as the relationship between life and non-life insurance penetration and growth, were found to be unidirectionally causal.

Olayungbo (2015) investigated the effects of life and non-life insurance on economic growth in Nigeria from 1976 to 2013. The Autoregressive Distributed lag model was adopted. Estimated results indicated a long-term correlation between economic life, non-life, and growth insurance in Nigeria over the research period. The advantages and noteworthy impact of life and non-life insurance for Nigeria's economic growth are further supported by both the short- and long-term dynamics.

From 1980 to 2011, Oyedotun and Adesina (2015) investigated how the insurance industry affected Nigeria's economic expansion. The study utilized GDP as the response variable as a stand-in for economic growth, and insurance investment as the explanatory variable. The exchange rate and inflation rate, two macroeconomic indicators, were included as moderating factors. In order to analyze the data, the study used the OLS regression approach, the ADF, and the Philip-Peron unit root test. It concluded that the insurance industry significantly contributed to economic growth.

Gabriel (2015) investigated the effect of insurance sector development on economic growth in for the period 1981 to 2013. Total insurance payment, total insurance premium, total insurance investment, and total insurance returns were utilized as predictive factors, while GDP—a proxy for economic growth—was chosen as the study's response variable. The statistical methods used for the data analysis included descriptive statistics, multiple regression (based on OLS), the Granger causality test, the ADF unit root test, the unconstrained co-integration test, and multiple regression. According to the findings, the GDP was significantly impacted negatively by the overall number of insurance claims, but positively by the total amount of insurance investment and premiums. The study found that the rise of the insurance industry had a significant impact on Nigeria's economic expansion.

Akinlo (2015) conducted an empirical investigation of the relationship between insurance business and economic growth using annual data of 30 Sub- Saharan African countries for the period 1995 to 2011. The study's dependent variable was the gross domestic product, which served as a stand-in for economic growth. The independent variables were interest rates, insurance premiums, inflation, and openness, which represented the development of insurance. He used the Granger causality test, co-integration test, and ADF unit root test as statistical methods for data analysis. The findings demonstrated that insurance granger causes GDP and GDP granger causes insurance. This indicates that the growth of the insurance industry has a significant effect on economic expansion.

Pradhan, MakArvin, Morman, Nair and Hall, (2016) studied the links between insurance penetration, market capitalization, broad money and economic growth in South East Asian nations using data from 1988 to 2012. The study uses the Granger causality approach; the study found that insurance penetration and economic growth are cointegrated.

Olayungbo and Akinlo (2016) studied the link between insurance penetration and economic growth in eight African countries for the period of 1970 - 2013. Both the short- and long-term relationships between the variables of interest were examined using a Bayesian Time Varying Parameter Vector Auto regression (TVP-VAR) model with stochastic volatility. The findings show that Egypt has a favorable association, whereas Kenya, Mauritius, and South Africa have both short-term and long-term negative effects. Conversely, Algeria, Nigeria, Tunisia, and Zimbabwe are proven to have adverse consequences.

Ukpong and Acha (2017) examined the co-integration and causal relationship between insurance and economic development in Nigeria for the period 1990 – 2013. Regression analysis and granger causality tests were used to analyse the data. There is a unidirectional relationship between GDP and total life insurance premiums, a bidirectional relationship between GDP and total non-life insurance premiums, and no causal relationship between GDP and total insurance investments, according to the Granger causality test. They come to the conclusion that insurance promotes economic growth. Nigeria's insurance industry and its impact on economic development and growth were examined by Nwafor (2017). Ordinary Least Squares regression was used to collect and analyze data from 2007 to 2016. The findings demonstrated that Nigeria's insurance industry significantly affects both the country's unemployment rate and economic development.

Ouedraogo, Guerineau, and Sawadogo (2018) used data from the World Bank's World Development Indicators, which covered the years 1996 to 2011, to examine the relationship between the growth of the life insurance industry and economic expansion in 86 developing nations. They used GDP, a stand-in for economic growth, as the response variable and the total life insurance premium as the explanatory variable. Descriptive statistics and the generalized moments method (GMM) were used in the study to analyze the data. The findings showed that the rise of the insurance industry had a favorable impact on economic expansion, however this varied per nation based on its structural features.

Fashagba (2018) explored the relationship between life and non-life insurance premium and economic growth in Nigeria. The study used secondary data that cover 2007 to 2016. The Ordinary Least Square Regression was utilized for data analysis. The study discovered a positive relationship between non-life insurance and Gross Domestic Products and negative relationship between life insurance and economic growth.

Iyodo, Samuel and Inyada (2018) determined the effect of non-life insurance penetration on economic growth in Nigeria using data covering the periods 1988-2014. Data were analyzed using regression. The autoregressive distributed lag was adopted to test hypotheses. Findings established that non-life insurance penetration had a positive and substantial effect on the economic growth in Nigeria during the period.

Adetunji, Nwude and Udeh (2018) carried out a research to examine the existence of positive and significant relationship between insurance penetration/activity and economic growth in Nigeria. Applying Ordinary Least Square model on Nigerian time series data for the period 1996–2015, the study revealed that insurance industry makes positive and significant contribution on Nigeria's economic growth.

The relationship between Nigeria's insurance penetration rate and economic growth between 1981 and 2017 was examined by Okonkwo and Eche (2019). Regression analysis was used to determine that the insurance business in Nigeria did not react well to government financial system changes and regulations, and that there is no meaningful correlation between the insurance penetration rate and the country's economic development. The insurance business appears to be struggling to win back the public's trust.

Nkoro, Ikue-John and Nwatah (2019) researched on the relationship between insurance industry and economic growth in Nigeria between 1980 and 2015. The study used descriptive statistics and various regression approaches based on Ordinary Least Squares. The results showed that the insurance industry's premiums had a detrimental effect on economic growth over the long and short terms. Therefore, they draw the conclusion that the Nigerian insurance business has not had a beneficial effect on the country's economic growth during the time under consideration, and that its activities and investments have not been significant or helpful to Nigeria's growth and development.

Lyndon (2019) investigated the relationship between insurance sector development and economic growth in Nigeria using data from 2001 to 2017. Gross domestic product was utilized as a stand-in for economic growth in the study, while the expansion of the insurance industry was represented by total insurance investment, total insurance premium, and total insurance claims. For data analysis, the study used multiple regression analysis and descriptive statistics. The empirical findings demonstrated a positive relationship between the gross domestic product and the overall amount of insurance investment, premiums, and claims. Therefore, it was determined that Nigeria's economic growth is significantly influenced by the expansion of the insurance industry.

Odior (2019) determined the insurance services sub-sectors impact on output performance in Nigeria from the period 1981-2017, using service exports and imports as proxy for insurance services. The study tests for stationary and co-integration using the Engle-Granger single-equation. The Generalized Linear Model was used to analyze the static impact. The results revealed that the insurance service exports has a positive significant impact on output performance, while insurance service imports does not have significant impact on output performance in Nigeria in the static analysis.

Nazar, Marzieh and Zohreh (2019) used of the Auto Regressive Distributed Lag (ARDL) approach during the period 1975-2016 to investigate the effects of insurance industry development on economic growth and income distribution in Iran. The results showed that the development of the insurance industry could provide simultaneous access to economic growth and income distribution in the short run. But in the long run, it will only lead to economic growth. However, in the long run, it could be reliant on human and physical capital for simultaneous access to economic growth and the distribution of income. Also, based on the error correction model, 88.2% and 68.1% of the non-equilibrium related to the non-oil per capita gross domestic product and Gini coefficient are adjusted in each period, respectively.

Makwe, Ibechiole and Obiaga (2021) carried out a research to ascertain the effect of insurance sector development on the economic growth of Nigeria. Data spanning 1980 to 2014 were tested using co-integration and analyzed using ordinary least square regression analysis. The results revealed among other discoveries, that there is a direct and meaningful link between insurance premium and economic growth in Nigeria.

Omoruyi-Aigbovo and Orobator (2023) examines the effect of insurance sector development on economic growth in ten selected emerging economies. Nigeria, South Africa, Indonesia, Colombia, Turkey, Latvia, Mexico, Argentina, Costa Rica, and China are among the nations that were chosen. For the years 2012–2016, the study makes use of descriptive statistics, correlation analysis, and pooled OLS regression. The expansion of the insurance industry has a positive and negligible effect on the growth of the chosen emerging nations, according to the empirical data. Therefore, the rise of the insurance industry does not promote economic expansion in the chosen emerging nations.

Aigbovo, and Iroh (2021) examines the short-run and long-run effect of insurance penetration rate on economic growth in Nigeria for the period 1980 - 2020. Correlation analysis, unit root tests, cointegration, error correction model, descriptive statistics, ordinary least squares, and the Granger causality test were all employed in the computation. The results showed that the insurance penetration rate significantly boosts Nigeria's economic growth over the long and short terms. Additionally, no correlation between the rate of insurance penetration and economic development was discovered.

Obayagbona, and Iroh (2023) examined the role of insurance sector development in the growth of the Nigerian economy for the period 1985 to 2022 (38 years). The data was analyzed using the Autoregressive Distributed Lags (ARDL) technique, and the empirical results show that insurance penetration (INPEN) has a weakly positive relationship with economic growth over the long term; insurance premiums (INPR) have a significant negative impact on the growth of the Nigerian economy; insurance assets (INASS) failed the 5% threshold, indicating that they do have a significant impact on the growth of the Nigerian economy; and insurance investment rate (INIVR) has a weakly negative relationship with economic growth in Nigeria in the long term compared to their current values.

Oloyede, Folorunsho and Ogamien (2023) examined the impact of insurance on economic growth in Nigeria from 1986 to 2020, using short run ordinary least square (OLS) model. The present study utilizes Real Gross Domestic Product (RGDP) as a proxy for economic growth, serving as the dependent variable while Total Insurance Premium (TIP), Total Insurance Claim (TIC), Total Insurance Investment (INV) and Inflation Rate were used as the explanatory variables. Short run of OLS result revealed that value total insurance claims, total insurance claim, total insurance investment and inflation rate had an insignificant impact on economic growth while total insurance premium has a significant relationship on economic growth. However, in the short run, insurance firm's indicator had a positive impact on economic growth in the short run and concluded that insurance firms indices has a positive impact on economic growth in the short run.

2.4.3 Carbon Footprint and Economic Growth: Empirical Evidence from Developed Countries

Different findings have been empirically established in the literature as it relate to the effect of carbon footprint on Economic Growth in developed countries. For instance, Grossman and Krueger (1993) analyzed the relationship between environmental quality and GDP per capita by focusing on the level of urban air pollution to estimate the turning point for the atmospheric concentration of suspended particular matter (SPM) and sulfur dioxide (SO_2). They proposed that air pollution can improve when GDP per capita increases to sufficient levels. They estimated the turning point to be $4,000~5,000 (in 1985 U.S. dollars). This is the point at which people typically become concerned about the quality of their environment. If GDP per capita is approximately $10,000, people may become involved in a number of activities to improve their environment, and thus, the quality of their environment is likely to improve considerably.

Seldon and Song (1994) analyzed the relationship between income and air pollutants by using fixed and random effect models with panel data. In contrast to Grossman and Krueger's turning point (i.e., $5,000 or less for SPM and SO_2), their turning point for these pollutants is greater than $8,000. They found that nitrogen oxides (NO_x) and sulfur dioxide (SO_2) have a Kuznets curve representing the existence of a relationship between national output and environmental quality.

Moomaw and Unruh (1997) examined the relationship between CO_2 and the level of income in developed countries. They selected 16 OECD member countries to investigate the EKC. Most of the countries showed an inverted U-shaped trend, and their turning point occurred between 1970 and 1980. Furthermore, by applying the cubic model specification to the 16 countries, they determined that the N-shaped curves for all the estimated coefficients were statistically significant. The first and second threshold points were between $12,810 and $18,330.

Friedl and Getzner's (2003) study showed that both linear and quadratic models were not suitable for analyzing the case of Austria but the cubic model can represent it more appropriately. The relationship between GDP and CO_2 emissions followed an N-shaped curve between 1960 and 1999. Galeotti and Lanza (2003) also confirmed the existence inverted U-shape curve for the relationship between CO_2 emissions and GDP.

Azomahou, Laisney and Van (2006) utilized a non-parametric approach to examine the EKC hypothesis for CO_2 emission employing data for 100 countries over the period 1960–1996. They found some evidence of the EKC hypothesis. Galeotti, Lanza, and Pauli (2006) studied the link between carbon emission and economic growth for the OECD and non-OECD countries. They find evidence for the EKC only for the OECD countries.

Huang, Lee and Wu (2008) examine the link between economic development and greenhouse gas (GHG) emissions utilizing the Kyoto Protocol arrangement that attempts to limit increases in GHG emissions among developed countries. They analyzed single-country time series and GDP data and found that most of the Annex II countries the Kyoto Protocol arrangements do not provide evidence supporting the EKC hypothesis.

Tamazian *et al*. (2009) investigate whether the EKC hypothesis hold for the BRIC nations and also the effect of financial development on carbon emissions for BRIC nations. Their empirical result of the bivariate analysis supported the EKC hypothesis for BRIC nations and based on their results they contends that economic development has reduced environment degradation in these countries. They also reported a negative relationship between financial development and carbon emissions for BRICs.

Choi, Heshmati and Cho (2010) test for the existence of the EKC for CO_2 emissions and its causal links with economic growth and openness by utilizing data for the period 1971 – 2006 from China, Korea, and Japan. The environmental implications according to openness and economic growth do not show the same results across the countries. Depending on the national characteristics, the estimated EKC show different temporal patterns. China shows an N-shaped curve while Japan has a U-shaped curve. Such dissimilarities are also found in the relationship between CO_2 emissions and openness. In the case of Korea and Japan it represents an inverted U-shaped curve, while China shows a U-shaped curve. They also analyze the dynamic relationships between the variables by adopting a vector auto regression or a vector error correction model. Results show evidence of large heterogeneity among the countries and variables impacts.

Jayanthakumaran, Verma and Liu (2012) explored the link between economic growth, energy consumption, trade openness and CO_2 emissions in India and China using the bounds testing approach to cointegration and the ARDL method to ascertain the long-run and short-run relationships between growth, trade, and energy use and endogenously determined structural breaks. The CO_2 emissions in China were influenced by per capita income, structural changes and energy consumption. A similar causal connection cannot be established for India with regard to structural changes and CO_2 emissions, because India's informal economy is much larger than China's. India possesses an extraordinarily large number of micro-enterprises that are low energy consumers and not competitive enough to reach international markets. Their empirical evidence confirmed the validation of EKC in both countries. Esteve and Tamarit (2012) applied a linear cointegration model with multiple structural changes based on the stability test proposed by Kejriwal and Perron to examine the EKC hypothesis in Spain from 1957–2007. The result did not confirm the EKC hypothesis.

Kasman and Duman (2015) employed panel co-integration and causality test based on panel ECM to examine the causal link between CO_2 emissions, electricity consumption, trade openness, economic growth and urbanization for a panel of 15 new EU member and candidate countries from 1992 to 2010. Their findings confirmed and support the EKC hypothesis.

Cederborg and Snobohm (2016) studied the link between per capita GDP and per capita CO_2 in order to observe their possible impact of economic growth and economic development. The study considered cross sectional data of 69 industrial countries as well as 45 poor countries.

Findings reveal that nexus between economic growth and economic development 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.

Al-Mulali and Ozturk (2016) studied the influence of energy prices on pollution and investigate the existence of environmental Kuznets curve (EKC) hypothesis in 27 advanced economies for the period 1990 – 2012 employing the panel non-stationary techniques. The results revealed that CO_2 emission, gross domestic product, renewable energy consumption, non-renewable energy consumption, trade openness, urbanization, and energy prices are cointegrated. Furthermore, the panel fully modified ordinary least square and the vector error correction Granger causality results revealed that gross domestic product, non-renewable energy, and urbanization increase CO_2 emission while renewable energy, trade openness, and energy prices reduces the emission of CO_2. Also, the existence of the EKC hypothesis was confirmed.

Sinha and Sudipta (2016) investigate the link between economic growth, CO_2 emission, trade volume, and human development indicator for Brazil, Russia, India, and China (BRIC countries) during 1980-2013 employing a generalized method of moments (GMM) method. The result indicates that bidirectional causality exists between CO_2 emissions and economic growth. Feedback hypothesis is supported between CO_2 emissions and human development, trade volume and human development, economic growth, and human development, and CO_2 emissions and trade volume. Apart from finding out the unidirectional association from trade volume to economic growth, this study also validated the existence of Environmental Kuznets curve.

Jardón, Kuik and Tol (2017) examine the nexus between carbon dioxide (CO_2) emissions per-capita and economic growth in a panel of 20 Latin American and Caribbean countries over the period 1971-2011. Findings suggests that the relationship between these variables, in the long run, follows an inverse U-shape, that is, from a certain level of per-capita income, an increased economic growth would be accompanied by improvements in environmental quality. Hence, the long-run equilibrium relationship between the variables cannot be established, and the result rejects the existence of an EKC.

Ketenci (2018) explores the nexus between carbon emissions and their main determinants such as energy consumption, real income, international trade, level of education and level of urbanization in the Russian employing data for the period 1991–2016. The ARDL bounds test is employed in order to estimate short-run and long-run relationships in the estimated model. Support for the environmental Kuznets curve hypothesis is found in this study, stating that environment pollution decreases in Russia after income achieves a certain threshold. Energy consumption, real income, education and urbanization levels are found to be significant determinants of carbon emissions, while trade openness does not have an impact.

Emir and Bekun (2019) examine the relationship between energy intensity, carbon emissions, renewable energy consumption, and economic growth in Romania between 1990 and 2014 on a quarterly data. The autoregressive distributive lag (ARDL) model for cointegration was employed, while direction of causality was tested using the Toda–Yamamoto model. Empirical findings reveal cointegration among the variables under consideration. The causality results show feedback causality between energy intensity and economic growth while uni-directional causality is seen running from renewable energy consumption to economic growth. Thus, this study affirms the energy-led growth hypothesis.

Claudio-Quiroga and Gil-Alana (2022) examines the relationship between the logarithms of carbon dioxide (CO_2) emissions and real Gross Domestic Product (GDP) in China for the period 1971 – 2015 employing the fractional integration and cointegration techniques. The univariate results indicate that the two series are highly persistent; their orders of integration being around two, while the cointegration tests (using both standard and fractional techniques) indicate that a long-run equilibrium relationship subsists between the two variables in first differences, i.e. their growth rates are linked together in the long run.

2.4.4 Carbon Footprint and Economic Growth: Empirical Evidence from Developing Countries

In this section we reviewed studies that test the EKC hypothesis in developing and emerging economies. For instance, Akbostanci, Türüt-Aşık and Đpek-Tunç (2009) explored the nexus between income and environmental degradation in Turkey, utilizing using a time series data spanning from 1968 - 2003. They found that CO_2 emissions and income tend to have a monotonically increasing relationship in the long run. This monotonically increasing relationship implies that the EKC hypothesis does not hold in this case. Halicioglu (2009) explore the relationship between economic growth, trade openness, CO_2 emissions and energy consumption for Turkey. The result showed that trade openness is one of main contributor to economic growth while income raises the levels of CO_2 emissions.

Narayan and Narayan (2010) test the Environment Kuznet's Curve (EKC) hypothesis for 43 developing countries from 1980–2004. The EKC hypothesis was examined based on the short- and long-run income elasticities approach; that is, if the long-run income elasticity is smaller than the short-run income elasticity then it is evident that a country has reduced carbon dioxide emissions as its income has increased. In 35 percent of the sample, the EKC hypothesis is correct. Additionally, the panel result for the Middle Eastern and South Asian panel provides evidence in favour of the EKC theory. The designated nations should anticipate reduced carbon emissions in the future along with increased economic growth.

Shahbaz, Lean and Shabir (2012) examined the nexus between CO_2 emissions, energy consumption, economic growth and trade openness in Pakistan over the period of 1971–2009. The result reveals that there exists a long-run relationship among the variables and therefore Environmental Kuznets Curve (EKC) hypothesis is supported. Saboori *et al*. (2012) examined the EKC hypothesis using time-series data from 1980–2009 in Malaysia. The EKC theory of an inverted-U connection is supported by the ARDL finding. According to the VECM causality test, there is no evidence of short-run causation; nonetheless, economic expansion has a unidirectional long-run causal relationship with carbon.

Over the course of 1966–2011, Tiwari, Shahbaz, and Adnan (2013) investigated the relationship between India's coal use, economic development, trade openness, and CO_2 emissions. The ARDL limits testing technique to cointegration is used to examine the long-run connection between the variables. The variables' cointegration is shown by the findings. Furthermore, the empirical conclusion demonstrates the existence of the long- and short-term versions of the Environmental Kuznets Curve (EKC). Furthermore, consumption of coal as well as openness to trade contributes to CO_2 emissions. The result of the causality indicates that feedback causality subsists between economic growth and CO_2 emissions and same outcome was also reported between coal consumption and CO_2 emissions.

Aduebe (2013) test the environmental Kuznets Curve (EKC) hypothesis for Nigeria using data from 1971 to 2011, a polynomial model was specified and estimated to ascertain the nature of the relationship between environmental degradation and income per capita. The estimation results provide confirmation in favor of an inverted U-shaped income-environmental degradation nexus in both long-run and short-run. This result supports the EKC hypothesis.

Mesagan (2015) investigated the link between CO_2 and economic growth in Nigeria from 1970 to 2013. The study employed ECM techniques, result indicate that in the current period, economic growth positively influence CO_2, while it negatively influences CO_2 emissions in the lagged period. It also revealed that trade openness (TOP) and capital investment, positively impact CO_2 emission in Nigeria.

The validity of the EKC hypothesis was investigated in 24 SSA countries between 1980 and 2010 by Ben-Jeblil, Ben-Youssef, and Ozturk (2015) using a panel OLS and FMOLS cointegration technique. The EKC theory of an inverted U connection was not supported by the long-term outcome. In SSA, imports and exports have an equal and opposite effect on carbon emissions.

Kwakwa and Adu (2016) examine the effect of income, energy, trade, urbanization and industrialization on CO_2 emission in selected sub-Saharan Africa (SSA) countries for the period 1980 - 2010. An inverted U-shaped association between income and CO_2 emissions, an inverted U-shaped relationship between trade and CO_2 emissions, and a positive influence from energy consumption and urbanisation were all supported by their estimated findings from the FMOLS and DOLS.

Alege and Ogundipe (2016) examine the nexus between environmental quality and economic growth in Nigeria using a fractional cointegration analysis over the period 1970-2011. The research indicates that Nigeria's initial phases of growth highlight the extent of environmental deterioration. Additionally, it discovers that environmental dumping contributes to a greater degree of environmental deterioration when commerce is unrestrained and institutions are weak. Ultimately, the findings indicate that higher population densities accelerate environmental mitigation efforts and raise awareness of the need for a cleaner environment. The study, however, failed to attain a reasonable turning point and hence a non-existence of EKC in Nigeria.

Alam, Murad, Noman, and Ozturk (2016) investigates the effects of income, energy consumption and population growth on CO_2 emissions in India, Indonesia, China, and Brazil for the period 1970 - 2012 employing the Autoregressive Distributed Lag (ARDL) bounds test approach to estimate both the short run and long run relationship. The findings demonstrate that in all four of the nations, increases in wealth and energy use have statistically significantly raised CO_2 emissions. In the medium and long terms, the association between CO_2 emissions and population increase has been determined to be statistically significant for Brazil and India, but statistically insignificant for China and Indonesia. Furthermore, empirical data from the environmental Kuznets curve (EKC) hypothesis test suggests that CO_2 emissions in Brazil, China, and Indonesia will gradually decline as wealth rises. Nonetheless, it was shown that CO_2 emissions and income in India were positively correlated; as a result, rising income over time will not result in a decrease in CO_2 emissions in the nation. Hence, the results suggests that the Environmental Kuznets curve exist in Indonesia and Brazil in both short-run and long-run while China supports the Kuznets curve hypothesis only in the long-run. India does not support Environmental Kuznets Curve hypothesis.

Alege and Ogundipe (2016) examined the causal link between CO_2 emissions, Electricity Consumption 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.

Awad and Warsame (2017) test the EKC hypothesis in the context of carbon emissions and economic growth relationship in 54 African Countries using a semi-parametric panel fixed effect regression. The EKC theory was not supported by the study's findings.

Kwakwa and Alhassan (2018) examine the effect of urbanization and energy on carbon dioxide emissions in Ghana within the framework of the Environmental Kuznets Curve (EKC) Hypothesis over the period 1971–2013. The existence of the EKC hypothesis for Ghana over the timeframe is confirmed by the estimation results obtained from Fully Modified OLS. Furthermore, it has been discovered that the use of combustible renewable energy sources, waste reduction, hydroelectric power generation, and trade openness all lower carbon dioxide emissions in Ghana, whereas the use of fossil fuels, their electricity generation, urbanisation, and industrialization all raise carbon dioxide emissions. However, the study indicates that although the connection between urbanisation and the use of fossil fuels has a negative effect on CO_2, the relationship between urbanisation and the consumption of combustible renewables and trash has a beneficial effect.

Sarkodie (2018) applied the ECM and Panel cointegration approach to investigate the determinants of pollution and degradation of the environment from 1971 to 2013 in 17 African countries. The EKC hypothesis was accepted by the study. Hundie (2018) applied the ARDL model with a polynomial specification and found evidence that carbon emission in Ethiopia is largely impacted by energy consumption, population, trade openness, and economic growth in the long run.

Kwakwa, Alhassan and Aboagye (2018) test the Environmental Kuznets Curve hypothesis in Tunisia for the period 1971 – 2016 employing a model that incorporate financial development and natural resource extraction. They found natural resource extraction exerts upward pressure on CO_2 emissions from the manufacturing and construction sector as well as from the consumption of gaseous fuels while the contrary is found for CO_2 emissions. The existence of the EKC hypothesis or otherwise within the context of financial development and natural resources extraction is found to be dependent on the source of CO_2 emissions in Tunisia.

Egbetokun *et al.* (2019) examines the EKC considering the impact of institutional quality on six variables of environmental pollution in Nigeria for the period 1970 - 2017. The EKC model includes population density, education expenditure, foreign direct investment, and gross domestic investment as control variables, and it was analyzed using the Auto Regressive Distribution Lag (ARDL) econometric technique, which has not been applied in the literature on Nigeria. The results, inter alia, indicate that there is EKC for CO_2 and SPM.

Acheampong, Adams and Boateng (2019) applied the fixed and random effect models to examine the impact of globalization and renewable energy on carbon emissions in 46 SSA countries from 1980–2015. The EKC theory is supported by the data. The outcome also indicates that trade openness exacerbates environmental deterioration while FDI and population decrease carbon emissions.

Adzawla, Sawaneh and Yusuf (2019) applied the ordinary least squares (OLS) approach to test the EKC hypothesis in the relationship between GHGs and economic growth in SSA from 1970–2012. As suggested by the EKC theory, the analysis found no indication of a turning point. A relationship with an inverted N-shaped relationship is shown by the OLS and VAR, respectively. Overall, the analysis finds that there is a long-term, monotonically declining link between economic development and environmental quality (using NH_4 emissions as a proxy).

The EKC hypothesis was tested in 23 East African countries between 1990 and 2013 by Demissew, Beyene, and Kotosz (2019) using the Pooled Mean Group (PMG) technique. Long-term rejection of the EKC hypothesis is contrasted with short-term estimation's acceptance.

Bah, Abdulwaki and Azam (2020) utilized a panel cointegration approach to examine the EKC hypothesis in 10 Middle-Income countries in SSA from 1971–2012. The outcome verified the validity of the EKC theory. Based on a country-specific examination, the EKC hypothesis has been validated in just three middle-lower income nations: Cote d'Ivoire, Kenya, and Nigeria; Mauritius, South Africa, and Botswana; and the middle-upper income countries, Mauritius, and South Africa.

Ajayi and Ogunrilola (2020) examine the relationship between growth, trade openness, and environmental degradation in Nigeria. The autoregressive distributed lag bounds testing approach was applied on time series data from 1960-2017. Employing the Pollution Haven and Environmental Kuznets Curve hypotheses, empirical findings validate the EKC hypothesis in Nigeria in the long-run. All estimated parameters were found to have the expected signs in the short- and long-run, except population, with the expected sign only in the long-run. The analysis proves that trade openness and population aid environmental degradation in the short-run. It reveals that financial development counters environmental degradation in both the short- and long-run, and real income per capita has a direct and significant influence on environmental degradation.

Mahmood, Alkhateeb and Furqan (2020) test the EKC for North African region using the spatial analysis. They included other control variables like imports, exports and foreign direct investment in their model. Their findings unveiled the existence of the EKC or bell-shaped nexus between economic growth and CO_2 emissions. Yusuf, Abubakar and Mamman (2020) investigated the EKC for selected oil producing African countries. They proved the EKC theory for methane gas emissions only.

Olubusoye and Dasuki (2020) examine the Environmental Kuznets Curve (EKC) hypothesis in 43 African countries pooled into 3 income groups from 1980–2016. For the estimate, three models were used: the Mean Group (MG), the Pooled Mean Group (PMG), and the ARDL model. Just 21% of the sample accepts the EKC hypothesis, whereas 70% of the nations in the sample as a whole reject it. The findings indicate that in 79% of the nations, carbon emissions rise in tandem with economic expansion, whilst in just 21% of the countries does economic growth result in a decrease in carbon emissions.

Alabi, Ojuolape and Yaqoob (2021) test the existence of EKC hypothesis Sri Lanka. This study also investigated the major factors behind environmental pollution and degradation in Sri Lanka for the period 1971 - 2014. ARDL technique was used in estimating the link between economic growth and environmental degradation. Results showed that neither the EKC hypothesis nor the pollution haven hypothesis is applicable to Sri Lanka. Long term estimates revealed that increasing energy consumption leads to increasing CO_2 emissions. Secondly, it was observed that energy consumption, urbanization, trade openness, tourism and financial development are among the key factors responsible for the quality of the environment. Bibi and Jamil (2021) examine the EKC hypothesis for North Africa and Sub-Saharan African Countries. Their result confirmed an inverted U-shaped relationship between economic growth and carbon emissions in North Africa, while their findings refuted the EKC hypothesis in Sub-Saharan Africa.

Fadun and Silwimba (2023) examined the role of insurance sector in Nigeria for the period 1992 to 2019. The study employed the cointegration technique and the findings showed that non-life premium and life premium were significant contribute to Nigerian economy.

Obayagbona (2023) investigates the relationship between carbon footprint and economic growth in Nigeria and Ghana over the period between 1990 and 2020 (31 years). The carbon footprint related variables used in the study include greenhouse gas emissions, renewable energy consumption, electricity consumption and trade openness. These variables have been regressed against gross domestic product per capita (a proxy for economic growth). The fully modified least square and panel dynamic least square have been employed for the main analysis of the study. The findings have revealed that greenhouse gas emissions and renewable energy consumption have a significant negative effect on economic growth in Nigeria and Ghana, while electricity consumption and trade openness have insignificant positive and negative relationships with economic growth respectively.

2.5 Summary Table of Reviewed Empirical Literature

The reviewed of empirical literature is summarized in Table 2.1.

Table 2.1: Tabular Summary of the Empirical Literature Reviewed

S/N	Author(s)/year	Country	Methodology	Sampled Periods	Findings
1	Moomaw and Unruh (1997)	16 OECD member countries	Pooled Regression	1970- 1980	Most of the countries showed an inverted U-shaped trend, and their turning point.
2	Beenstock, Dickinson and Khajuria (1988)	12 countries	Pooled Regression	1970- 1981	The results show that interest rates and GNP have an impact on premiums; the marginal willingness to insure, both in the short and long term, increases with per capita income and are always greater in the long term.
3	Outreville (1990)	For 55 developing countries.	Panel Regression	1983- 1984	Results show that there is a substantial correlation between GDP and property liability insurance.
4	Ward and Zurbruegg (2000)	9 OECD countries	Multiple regression and bivariate VAR Granger causality test	1961-1996	The researchers discovered that different nations had different causal relationships between the development of the insurance market and economic growth.
5	Brown (2000)	OECD Countries	Pooled OLS	1986 -1993	While wealth and loss likelihood have a negative correlation with insurance consumption, income and the legal system have a positive correlation.
6	Webb, Grace and Skipper (2002)	55 developed and developing countries	Regression	1980- 1996	They discovered that higher productivity is strongly predicted by the exogenous factors of banking and life insurance penetration. They also discovered no connection

					between non-life insurance and economic development. The prevalence of life insurance is impacted by economic expansion, although banking development is not predicted by it.
7	Iyiola and Rechard (2007)	Nigeria	Ordinary Least Square.	1996-2012	Findings revealed that insurance did not significantly contribute to Nigeria's real gross domestic product between
8	Kugler and Ofoghi (2005)	United Kingdom	Regression and Granger causality tests	1966-2003	Findings show that eight out of nine markets (the exception is pecuniary loss insurance) that the long run relationship between insurance market size development and economic growth is present rather than there is cyclical effect. Additionally, they found that causality from GDP growth to insurance market size development is more powerful than the causality from the other side.
9	Haiss and Sümegi (2008)	29 European countries	Panel Data Regression	1992–2005	Their research implied that there were differences between less developed countries and countries with financial markets that were in a mature stage of development. Also, in the markets of EU-15, Switzerland, Norway and Iceland, there was a positive impact of life

					insurance on real GDP growth. Still, liability insurance had bigger impact in new EU member states in Central and Eastern Europe.
10	Arena (2008)	55 high, middle and low income countries	Panel Regression	1976-2004	Findings support a causual effect of insurance to economic growth. However, the research results evidence different impact of life and non-life insurance on economic growth. Additionally, he found that life insurance would have a bigger impact on economic growth at low levels of economic development and non-life insurance at middle levels.
11	Tamazian et al. (2009)	BRIC nations	Panel Regression	1990- 2006	Findings supported the EKC hypothesis for BRIC nations.
12	Akbostanci, Türüt-Aşık and Đpek-Tunç (2009)	developing and emerging economies	Panel Data Regression	1968- 2003	They found that CO_2 emissions and income tend to have a monotonically increasing relationship in the long run. This monotonically increasing relationship implies that the EKC hypothesis does not hold in this case.
13	Marijuana, Sandra and Lime (2009)	10 transition European Union Member	Panel Regression	1992-2007	Findings show that insurance sector development positively and significantly affects

		Countries			economic growth.
14	Choi, Heshmati and Cho (2010)	China, Korea, and Japan	Vector Auto Regression or a Vector Error Correction Model	1971-2006	The estimated EKC show different temporal patterns. China shows an N-shaped curve while Japan has a U-shaped curve.
15	Han et al. (2010)	77 develop[ed and developing countries	GMM	1994–2005	Findings show that insurance market development, as well as the development of individually observed life and non-life insurance markets, had a far more significant role for developing economies than for developed economies.
16	Njegomir and Stojić (2010)	Ex-Yugoslavia region	Fixed Effects Regression	2004-2008	Findings show that insurers provide positive effect on economic growth both as providers of insurance risk management and indemnification and as institutional investors.
17	Lee (2011)	10 selected OECD countries	Panel Regression and Granger Causality Test	1979-2006	Findings reveal a significant relationship between insurance market activities and economic while the panel causality show strong evidence of a two-way long-term and short-term causal relationship between insurance market development and

					economic growth.
18	Omoke (2012)	Nigeria	Vector Error Correction Approach	1970- 2008	Findings showed a long term relationship existing among the variables. The result reveals that the insurance sector has no positive and significant effect on economic growth in Nigeria within the period of study.
19	Ching, Kogid and Mulok (2011)	Malaysia	Autoregressive Distributed Lag (ARDL), Granger causality test and Error Correction Model (ECM)	1997-2008	Findings showed that total assets of the general insurance sector positively affected economic growth.
20	Mojekwu, Agwuegbo and Olowokudejo (2015)	Nigeria	Ordinary Least Square	1981- 2008	Findings revealed positive relationship between insurance business and economic growth.
21	Kjosevski (2013)	Macedonia	Multiple Regression	1995- 2010	Findings show that the three indices of independent variable, that is Life insurance, non-life insurance and total penetration significantly influence economic growth.
22	Ming, Yung and Ting (2012)	Taiwan	Vector Autoregressive (VAR) model	1961- 2006	They found symmetry relationship between insurance demand, financial development and GDP growth.
23	Oke (2012)	Nigeria	Fixed-Effect Regression	1985- 2009	Findings revealed that insurance sector growth

					and development positively and significantly affects economic growth.
24	Shahbaz, Lean and Shabir (2012)	Pakistan	Multiple Regression	1971–2009	Findings reveal that there exists a long-run relationship among the variables and therefore Environmental Kuznets Curve (EKC) hypothesis is supported.
25	Saboori et al. (2012)	Malaysia	ARDL and VECM causality test	1980–2009	Findings support the EKC theory. Also, there is no evidence of short-run causation; nonetheless, economic expansion has a unidirectional long-run causal relationship with carbon.
26	Tiwari, Shahbaz, and Adnan (2013)	India	ARDL	1966–2011	Findings demonstrate the existence of the long- and short-term versions of the Environmental Kuznets Curve (EKC).
27	Aduebe (2013)	Nigeria		1971- 2011	Findings support the EKC hypothesis.
28	Yinusa and Akinlo (2013)	Nigeria	Error Correction Model (ECM)	1986–2010	Findings indicate statistically significant contribution of insurance to economic growth in Nigeria.
29	Victor (2013)	Nigeria	Multiple Regression	1980- 2011	Finding show a strong relationship between insurance and economic growth.

30	Eze and Okoye (2013)	Nigeria	Multiple Regression and Granger Causality Test	1985- 2011	Findings show that the insurance premium capital has significantly impacted on economic growth while the level of total insurance investment has significantly effected on economic growth and that there is causal relationship between insurance sector development and economic growth.
31	Chau, Khin and Teng (2013)	Malaysia	Granger Causality Test and Error Correction Method (ECM)	1970- 2012	Findings showed that total employment and life insurance premium had short run significant positive impact on economic growth, while capital stock and general insurance had positive significant effect on economic growth in the long run.
32	Chang, Lee and Chang (2013)	10 OECD countries	A Bootstrap Panel Granger Causality Test	1979-2006	They found evidence of one- way Granger causality running from insurance activities to GDP in 5 out of OECD countries. Secondly they found evidence of one-way Granger causality running from GDP to insurance activities in Canada Italy and the US.
33	Cristea, Marcu and Carstina (2013)	Romania	Pearson Correlation	1980- 2010	Findings indicate that there is high correlation between the insurance market and gross domestic

					product growth in term of causal link.
34	Zouhaier (2014)	23 OECD countries	Panel Regression	1990- 2011	Findings revealed that non-life insurance, as measured by the penetration rate had a positive and significant impact on economic growth; and a negative effect was exerted by the total insurance and non-life insurance, as measured by the insurance density on economic growth.
35	Sibindi and Godi (2014)	South Africa	Granger causality based on the Vector Error Correction Model (VECM).	1990- 2012	Findings confirm the existence of at least one cointegrating relationship and also indicate that the direction of causality runs from the economy to the long-term insurance, as well as from the economy to the total insurance sector.
36	Madukwe and Obi-Nweke (2014)	Nigeria	Pearson's Correlation	2000- 2011	Findings indicated a strong positive relationship between insurance business and economic growth.
37	Alhassan and Fiador (2014)	Ghana	autoregressive distributed lag (ARDL) bounds approach and Granger Causality Test	1990-2010.	A unidirectional causality was found from aggregate insurance penetration to growth on one hand and life and non-life insurance penetration to growth on the other hand.

38	Olayungbo (2015)	Nigeria	Autoregressive Distributed lag model	1976- 2013	Findings showed a long run relationship to exist among economic life, non-life insurance and economic growth. The long run and the short run dynamics further confirms the positive and significant contribution of life and non-life insurance on economic growth in Nigeria.
39	Oyedotun and Adesina (2015)	Nigeria	OLS regression	1980- 2011	Findings reveal that insurance business made strong contribution to economic growth.
40	Gabriel (2015)	Nigeria.	Descriptive Statistics and Multiple Regression	1981- 2013	Findings revealed that total insurance investment and total insurance premium had significant positive link with GDP, while total insurance claims had significant negative effect on GDP.
41	Akinlo (2015)	30 Sub-Saharan African countries	Granger Causality Test	1995- 2011	The results established that GDP granger cause insurance and insurance granger cause GDP. This means that insurance sector development exerted considerable impact on economic growth.
42	Mesagan (2015)	Nigeria	OLS	1970- 2013	Findings indicate that in the current period, economic growth positively influence CO_2, while it negatively

					influences CO_2 emissions in the lagged period.
43	Ben-Jeblil, Ben-Youssef, and Ozturk (2015)	24 SSA countries	panel OLS and FMOLS	1980-2010	The EKC theory of an inverted U connection was not supported by the long-term outcome.
44	Pradhan, MakArvin, Morman, Nair and Hall, (2016)	South East Asian Nations	Granger Causality Approach	1988- 2012	The study found that insurance penetration granger cause economic growth.
45	Olayungbo and Akinlo (2016)	8 African Countries	Bayesian Time Varying Parameter Vector Auto regression (TVP-VAR)	1970- 2013	Findings reveal a positive relationship for Egypt, while short-run negative and long-run positive effects are found for Kenya, Mauritius, and South Africa. On the contrary, negative effects are found for Algeria, Nigeria, Tunisia, and Zimbabwe.
46	Kwakwa and Adu (2016)	selected sub-Saharan Africa (SSA) countries	FMOLS and DOLS	1980- 2010	Findings reveal an inverted U-shaped relationship between trade and CO_2 emissions, and a positive influence from energy consumption on economic growth.
47	Alege and Ogundipe (2016)	Nigeria	Fractional Cointegration Analysis	1970-2011	Findings failed to attain a reasonable turning point and hence a non-existence of EKC in Nigeria
48	Alam, Murad, Noman, and Ozturk (2016)	India, Indonesia, China, and	Autoregressive Distributed Lag (ARDL) bounds	1970- 2012	The findings reveal that the Environmental Kuznets curve exist in

		Brazil	test		Indonesia and Brazil in both short-run and long-run while China supports the Kuznets curve hypothesis only in the long-run. India does not support Environmental Kuznets Curve hypothesis.
49	Alege and Ogundipe (2016)	Nigeria	granger causality test	1970- 2013	Findings indicate that fossil fuel increases carbon emissions while, renewable energy (electricity) reduce the atmospheric concentration of CO_2 emissions.
50	Awad and Warsame (2017)	54 African Countries	semi-parametric panel fixed effect regression	1980- 2015	The EKC theory was not supported by the study's findings.
51	Ukpong and Acha (2017)	Nigeria	Regression Analysis and Granger Causality Tests	1990- 2013	Findings revealed that there is a bidirectional relationship existing between GDP and total non-life insurance premiums while a unidirectional relationship exists between GDP and total life insurance premiums with no causal relationship existing between GDP and total insurance investments. They conclude that insurance contributes to economic development.
52	Nwafor (2017)	Nigeria	Ordinary Least Squares	2007- 2016	Findings showed that insurance business in Nigeria has significant

			Regression		impact on economic growth and unemployment rate in Nigeria.
53	Ul Din, Abu-Bakar and Regupathi (2017)	20 developed and developing countries	Fixed Effect Regression	2006- 2015	The researchers found a positive and significant relationship between life insurance, measured through net written premiums and insurance density, and economic growth for developed countries while the same is true for developing countries when insurance is measured through penetration proxy.
54	Demirci and Zeren (2017)	13 OECD Countries	Panel Granger Causality Test	1983–2011	Findings indicate the existence of a causality between the insurance premium per capita and real GDP in 4 out of 13 analysed countries (France, Iceland, Italy and Spain).
55	Ouedraogo, Guerineau and Sawadogo (2018)	86 Developing Countries	Generalized Moments Method (GMM)	1996- 2011	Findings indicates that insurance sector development had positive effect on economic growth;
56	Fashagba (2018)	Nigeria	Ordinary Least Square Regression	2007- 2016	Findings show a positive relationship between non-life insurance and Gross Domestic Products and negative relationship between life insurance and economic growth.

57	Iyodo, Samuel and Inyada (2018)	Nigeria	Autoregressive Distributed Lag (ARDL)	1988- 2014	Findings established that non-life insurance penetration had a positive and substantial effect on the economic growth in Nigeria during the period.
58	Adetunji, Nwude and Udeh (2018)	Nigeria	Ordinary Least Square Regression	1996–2015	Findings revealed that insurance industry makes positive and significant contribution on Nigeria's economic growth.
59	Kwakwa and Alhassan (2018)	Ghana	Fully Modified OLS	1971–2013	The existence of the EKC hypothesis for Ghana over the timeframe is confirmed by the estimated result,
60	Sarkodie (2018)	17 African countries	ECM and Panel cointegration	1971- 2013	The EKC hypothesis was accepted by the study.
61	Hundie (2018)	Ethiopia	ARDL	1980-2015	Found evidence that carbon emission is largely impacted by energy consumption, population, trade openness, and economic growth in the long run.
62	Kwakwa, Alhassan and Aboagye (2018)	Tunisia	ARDL bounds test	1971–2016	The existence of the EKC hypothesis or otherwise within the context of financial development and natural resources extraction is found to be dependent on the source of CO2 emissions in Tunisia.
63	Ketenci (2018)	Russian	ARDL bounds test	1991–2016	Findings support the environmental Kuznets

					curve hypothesis
64	Emir and Bekun (2019)	Romania	autoregressive distributive lag (ARDL)	1990- 2014	Findings reveal cointegration among the variables under consideration. The causality results show feedback causality between energy intensity and economic growth while uni-directional causality is seen running from renewable energy consumption to economic growth.
65	Peleckienė, Peleckis, Dudzevičiūtė and Peleckis (2019)	27 EU countries	Panel Granger Causality Test	2004–2015	Findings showed that there was two-way causality in the case of Austria, and no causality between the variables in the case of Slovakia. The results of the conducted test showed the existence of one-way causality from GDP per capita to total premiums per insured in some countries.
66	Nazar, Marzieh and Zohreh (2019)	Iran	Auto Regressive Distributed Lag (ARDL)	1975-2016	Findings showed that the development of the insurance industry could provide simultaneous access to economic growth and income distribution in the short run.
67	Okonkwo and Eche (2019)	Nigeria	Ordinary Least Square Regression	1981-2017	Findings established that there is no significant relationship between insurance penetration rate

					and economic growth of Nigeria
68	Lyndon (2019)	Nigeria	Ordinary Least Square Regression	2001- 2017	Findings established that total insurance investment, total insurance premium and total insurance claims had positive effect on gross domestic product.
69	Odior (2019)	Nigeria	Generalized Linear Model	1981-2017	Findings revealed that the insurance service exports has a positive significant impact on output performance, while insurance service imports does not have significant impact on output performance in Nigeria in the static analysis.
70	Nkoro, Ikue-John and Nwatah (2019)	Nigeria	Ordinary Least Square multiple regression	1980- 2015	Findings revealed that the premium of insurance industry impacts negatively on economic growth both in the long and short run period.
71	Egbetokun, et al., (2019)	Nigeria	the Auto Regressive Distribution Lag (ARDL)	1970- 2017	The results, inter alia, indicate that there is EKC for CO2 and SPM.
72	Acheampong, Adams and Boateng (2019)	46 SSA countries	Fixed And Random Effect Regression	1980–2015	The EKC theory is supported by the data.
73	Adzawla, Sawaneh and Yusuf (2019)	SSA	Ordinary Least Squares (OLS) and VAR	1970–2012	Overall, the analysis finds that there is a long-term, monotonically declining

					link between economic development and environmental quality (using NH4 emissions as a proxy).
74	Demissew, Beyene, and Kotosz (2019)	23 East African countries	Pooled Mean Group (PMG)	1990- 2013	Long-term rejection of the EKC hypothesis is contrasted with short-term estimation's acceptance.
75	Apergis and Poufinas (2020)	27 OECD countries	Panel Granger Causality Test	2006–2016	Findings indicate that there was a statistically significant two-way causality between economic growth and gross insurance premium (total and life insurance premium), and in the case of gross non- life insurance premium the causality was one-way from GDP to gross non-life insurance premiums.
76	Bah, Abdulwaki and Azam (2020)	10 Middle-Income Countries in SSA	Autoregressive Distributed Lags (ARDL)	1971–2012	The outcome verified the validity of the EKC theory.
77	Ajayi and Ogunrilola (2020)	Nigeria	Autoregressive Distributed Lags (ARDL)	1960-2017	Findings validate the EKC hypothesis in Nigeria.
78	Mahmood, Alkhateeb and Furqan (2020)	Selected African countries	Spatial Analysis	1995–2016	Findings unveiled the existence of the EKC or bell-shaped nexus between economic growth and CO_2 emissions.
79	Yusuf, Abubakar & Mamman	Selected African countries	Autoregressive Distributed Lags (ARDL)	1990–2017	They proved the EKC theory for methane gas emissions only.

	(2020)				
80	Dasuki and Olubusoye (2020)	43 African countries	Mean Group (MG), the Pooled Mean Group (PMG), and the ARDL	1980–2016	Findings indicate that in 79% of the nations, carbon emissions rise in tandem with economic expansion, whilst in just 21% of the countries does economic growth result in a decrease in carbon emissions.
81	Alabi, Ojuolape and Yaqoob (2021)	Sri Lanka	Autoregressive Distributed Lags (ARDL)	1971- 2014	Findings showed that neither the EKC hypothesis nor the pollution haven hypothesis is applicable to Sri Lanka. Long term estimates revealed that increasing energy consumption leads to increasing CO_2 emissions.
82	Bibi and Jamil (2021)	North Africa and Sub-Saharan African Countries	Autoregressive Distributed Lags (ARDL)	2015-2019	Findings confirmed an inverted U-shaped relationship between economic growth and carbon emissions in North Africa, while their findings refuted the EKC hypothesis in Sub-Saharan Africa.
83	Makwe, Ibechiole and Obiaga (2021)	Nigeria	Ordinary Least Square multiple regression	1980 -2014	Findings revealed among other discoveries, that there is a positive and significant relationship between insurance premium and economic growth in Nigeria.
84	Aigbovo, and	Nigeria	Ordinary Least Squares And	1980-2020	Findings revealed that insurance penetration rate

	Iroh (2021)		Granger Causality Test		exerts significant positive impact on economic growth in Nigeria in both short-run and long-run. Also, no causal link was found between insurance penetration rate and economic growth.
85	Claudio-Quiroga & Gil-Alana (2022)	China	fractional integration and cointegration	1971-2015	Findings indicate that a long-run equilibrium relationship subsists between the two variables in first differences, i.e. their growth rates are linked together in the long run.
86	Mirela, Miloš and Milijana (2022)	11 EU Countries	Panel Regression	1998-2018	Findings show that in the short run, premium per capita has a positive and significant impact on the economic growth in the case of individual countries, except in the case of Ireland and Luxembourg, where the applied model shows only error-correction coefficient values.
87	Dawd and Benlagha (2023)	16 OECD countries	GMM	2009 -2020	Finding revealed that insurance sector development significantly impacted economic growth; coupled with fact that the inverted U-shaped relationship was also confirmed in the study.
88	Omoruyi-Aigbovo and	Emerging Economies	Pooled OLS	2012-2016	Findings revealed that insurance sector

	Orobator (2023)	(Nigeria, South Africa, Indonesia, Colombia, Turkey, Latvia, Mexico, Argentina, Costa Rica and China).	Regression		development has a positive and insignificant impact on the growth in the selected emerging countries.
89	Obayagbona, and Iroh (2023)	Nigeria	Autoregressive Distributed Lags (ARDL)	1985- 2022	Findings indicate that insurance penetration (INPEN) has a weak positive relationship with economic growth in the long run; insurance premium (INPR) has a significant negative impact on the growth of the Nigerian economy; insurance assets (INASS) does not have significant impact on the growth while insurance investment rate (INIVR) has a weak negative relationship with economic growth in Nigeria;
90	Oloyede, Folorunsho and Ogamien (2023)	Nigeria	Ordinary Least Square (OLS) Regression	1986- 2020	Findings revealed that value of total insurance claims, total insurance investment and inflation rate had an insignificant impact on economic growth while total insurance premium has a significant relationship on economic growth.

91	Fadun and Silwimba (2023)	Nigeria	Ordinary Least Square (OLS) Regression	1992- 2019	Findings showed that non-life premium and life premium were significant contribute to Nigerian economy.
92	Obayagbona (2023)	Nigeria and Ghana	The Fully Modified Least Square and Panel Dynamic Least Square	1990- 2020	Findings have revealed that greenhouse gas emissions and renewable energy consumption have a significant negative effect on economic growth in Nigeria and Ghana, while electricity consumption and trade openness have insignificant positive and negative relationships with economic growth respectively.

Source: Author's Compilation, (2025).

2.6 Research Gap in the Empirical Literature

From the survey of extant empirical literature on the influence of insurance sector development on economic growth, the following gaps in knowledge became evident. For instance, researchers such as Ćurak, Loncar and Poposki (2009); Haiss and Sumegi (2008); Arena (2008); Marijuana, Sandra and Lime (2009); Njegomir and Stojic (2010); Pen-Fen, Chen and Chen (2011) and UI-Din, Abubakar and Regupathi (2017) among others, have investigated the relationship between insurance sector development and economic growth. They found that insurance sector development had positive and significant impact on economic growth. On the other hand, the studies of Webb, Grace and Skipper (2002); Omoke (2012) and Omoruyi-Aigbovo and Orobator

(2023) among others have found that insurance sector development had no significant effect on economic growth.

Also, the findings of earlier research are likewise conflicting with regard to the connection between carbon footprint and economic growth which has been studied and discussed in Environmental Kuznets Curve (EKC) which is also known as the EKC hypothesis. Some studies confirmed the EKC hypothesis with an inverted U-shaped relationship between economic growth and carbon footprint (Alam, Murad & Nomanc, 2016; Al-Mulali & Ozturk, 2016; Kwakwa & Adu, 2016; Sinha & Sen, 2016; Aboagye, 2017; Sinha & Shahbaz, 2018; Dong, Sun & Li 2018). In contrast, other studies reported non-existence of EKC, arguing that increase economic growth reduces carbon footprint (Onafowora & Owoye, 2014; Nassani, Aldakhil & Abro, 2017; Pal & Mitra, 2017; Sinha, Shahbaz & Balsalobre – Lorente, 2017; Balsalobre-Lorente, Shahbaz, Roubaud & Farhani, 2018).

These different findings could be attributed to difference in variables used, technique in measurement of variables, scope adopted, and difference in estimation techniques employed in their studies. All these could be responsible for these mixed findings. Thus, there is need for more studies in this area to reconcile these differences and utilize recent data to investigate the effect of insurance sector development and carbon footprint on economic growth in the context of sub-Saharan African countries.

Apart from mixed findings that exist among prior studies in the literature on the foregoing discourse, methodological gap of studies in this discourse that used the Mean Group (MG) and the Pooled Mean Group (PMG) technique that allows for a higher degree of parameter heterogeneity in regressions than the other estimators is very scarce or not in existence in the sub-Saharan African countries context to the best of the researchers knowledge. Hence, unlike previous studies on this subject matter, this study overcome the problem of parameter heterogeneity as it will employ the Mean Group (MG) and the Pooled Mean Group (PMG) estimation technique to examine the long-run and short-run nexus amongst the variables and contributes to extant literatures new empirical evidence on the influence of insurance sector development and carbon footprint on economic growth in Sub-Saharan African countries.

Also, there are several empirical studies which focus on relationship between financial development and economic growth in sub-Saharan African countries, however, majority of these studies focus on the relationship between stock market development and economic growth or banking sector development and economic growth. On the contrary, there is dearth of studies that examine the impact of insurance sector development on economic growth in sub-Saharan African countries when compared to that of stock market development and economic growth or banking sector development and economic growth. The number of empirical studies on the link between insurance sector development and economic growth is relatively few for sub-Saharan African countries probably due to the small size of the sector before the reforms in the early 80s - 2005. Indeed, most existing studies on insurance-growth nexus have focused on the developed countries of Western Europe as well as emerging Asian markets. This is no doubt a gap in the literature which needs to be filled. Hence, this study attempts to fill this gap in knowledge by adding to the few empirical studies that investigate the insurance-growth nexus in sub-Saharan African countries using the most recent data.

Furthermore, a number of studies have been carried out to analyse the effect of insurance sector development on economic growth (Njegomir & Stojic, 2010; Pen-Fen, Chen & Chen, 2011; UI-Din, Abubakar & Regupathi, 2017; and Omoruyi-Aigbovo & Orobator, 2023 among others) as well as effect of carbon footprint on economic growth (Pal & Mitra, 2017; Sinha, et el., 2017;

Aboagye, 2017; Sinha & Shahbaz, 2018; Dong, Sun & Li 2018; Balsalobre-Lorente, et al., 2018 among others), it was observed from the survey of extant literature that studies that have examine the moderating influence of insurance sector development on the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries is very scarce or not in existence to the best of researchers knowledge. Hence, the moderating influence of insurance sector development on the relationship between carbon footprint and economic growth is largely unexplored in previous studies. Hence, this study will provide a new dimension that includes insurance sector development in relation to carbon footprint and economic growth in sub-Saharan Africa countries.

This present study is an attempt to fill or bridge these gaps in knowledge by empirically examining the effect of insurance sector development and carbon footprint on economic growth in selected sub-Saharan Africa countries.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The careful description of the methods to be used in providing answers to the research questions raised is the focus of this chapter. It explains the research design, population and sampling, data source, theoretical framework, model specification, and method of data analysis.

3.2 Research Design

The longitudinal research design was used in this study. This enables the researcher to ascertain the impact of explanatory variables on the dependent variable from historical data. Longitudinal research design is usually retrospective in terms of data stream and time. This study adopted this research design because insurance sector development, carbon footprint and economic growth data to be extracted are historical and span across period of time, precisely 2000 to 2023 on the variables of interest. Also the design helps to ascertain the cause and effect relationship that may exist between the dependent and independent variables.

3.3 Population and Sample of the Study

The population of the study comprises all the forty eight (48) countries that make up the Sub-Saharan African region according to World Bank (2023).

3.4 Sampling Technique and Sample Size of the Study

A convenient sample of nineteen (19) countries (Angola, Benin, Botswana, Burkina Faso, Cape Verde, Cameroon, Cote d'Ivoire, Ghana, Kenya, Mauritius, Namibia, Niger, Nigeria, Senegal, South Africa, Tazania, Togo, Uganda, and Zambia) was included in the study. This sample was selected by data filtering technique based on the following three criteria: (i) availability of data for the period of study (2000 – 2023); (ii) they represent some of the most developed insurance sector and most active economies in the Sub-Saharan African region and (iii) regionalization was considered in the country selection and inclusion (that is, Kenya, Uganda and Tazania from the East Africa region; Nigeria, Ghana, Senegal, Benin, Burkina Faso, Cape Verde, Cameroon, Cote'Ivoire, Niger and Togo from West Africa region; while Angola, Botswana, Mauritius, Namibia, South Africa and Zambia represent the South African sub-region).

3.5 Sources of Data

The data for this study were sourced from the World Bank's Development Indicators (WDI) of 2023 and the Global Footprint Network (2023). The data was collected for the period 2000 to 2023.

3.6 Theoretical Framework

This study is underpinned by the Environmental Kuznets Curve (EKC) hypothesis and the endogenous growth model. The EKC hypothesis posits that, ats an initial stage of economic growth and development is associated with a higher level of carbon footprint and pollution until a certain stage of economic development will gradually improve environmental quality. This implies that after some turning points, economic growth may actually bring some ecological benefits (Grossman & Krueger, 1991, 1993, 1995). On the other hand, the endogenous growth theory as postulated by Pagano (1993) posits that capital accumulation can increase the long run trend of economic growth and this accumulation is reliant on increasing the savings rate. Effective insurance sector engender economic growth by spurring investments and technological innovations through savings. These they do through the premiums collected which are then used by insurance companies in the financial and investment operation of the economy. As a result, this process boosts the economic growth. The AK model can be used to demonstrate the potential effectiveness of the development of the insurance sector on growth emanating in the economy, and as stated, output that is accumulated is a function of capital that is accumulated in a linear function. The endogenous theory offers a framework where outcome equals the product of labour and capital and growth is argued to originate from endogenous factors within the economy.

$Y_t = AK_t$ …………………………………………………………………………….. (3.1)

where A is the production factor, K_t is the total capitalization measured at time (t), and Y_t is the total output measured at time (t).

It is assumed that there is only one product in the economy, that the population is immobile, and that it can only be used for consumption or investment. When displaying investments in gross terms, we take into account the rate of impairment δ.

$K_{t-1} = (1 - \delta)K_t$…………………………………………………………………… (3.2)

Where 1 is the period t investment, K_{t-1} and K_t is the capitalization in period $t + 1$ as well as t in their respective manner and δ is impairment rate.

Where we have zero interventions by government and an economy that is closed and two sector, market intersections requires that savings equal investments. Pagano (1993) assumes that a proportion of the resources $I - \theta$ are absorbed during the financial intermediation process and thus the proportion θ of total savings is accorded to investments. The savings-investments relationship can therefore be illustrated as;

$= I_t$……………………………………………………………………..……………(3.3)

We can now use equation (3.1) to introduce rate at which economy grows at period $t + 1$ which is

$I_{t+1} = {Y_{t+1}}/{Y_{t-1}} = {K_{t+1}}/{K_{t-1}}$………………………………………………… (3.4)

Making use of equation (3.2) and expunging the index of periods, the rate of growth in a state that is steady growth rate of output can now be illustrated as;

$= A\,{I}/{Y} - \delta = A\theta S - \delta$………………………………………………………… (3.5)

From equation (3.5) economic growth is dependent on productivity factor in total A, intermediation of financial systems efficiency index θ and the savings rate S. According to Liu (2011), financial institutions (in this case insurance firms) can enhance expansion of economy by raising the weight in savings converting to investments. Improving the efficiency of the financial system lowers $I - \theta$ and enhances g. Following Bakang (2015) in assuming that depreciation is constant and substituting variables, economic growth is dependent on insurance sector development and Y_1 can be expressed as;

$Y_1 = \beta_0 + \beta_1\,{S_t}/{Y_{it}} + \varepsilon$……………………………………………………………… (3.6)

where S_t/Y_it is the insurance sector development, as measured by insurance penetration rate, insurance density, and gross premium, and Y_t is the GDPPC of Sub-Saharan African nations. The intercept is β_0, the coefficient that indicates how the expansion of the insurance industry affects economic growth is β_1, and the constant error term is ε.

If carbon footprint and control variables are added to Equation 3.6, we then have:

$Y_t = \beta_0 + \beta_1\,{S_t}/{Y_{it}} + \beta_2\,CF_t + \beta_2\,B_t + \varepsilon_t$…………………………………………… (3.7)

Where; CF is carbon footprint, B are the model's control variables.

3.7 Model Specification

The Environmental Kuznets Curve (EKC) hypothesis and the endogenous growth model, served as the foundation for the models used in this investigation. The study used real gross domestic product in a country per year as the proxy for economic growth. Also, we employed three proxies for insurance sector development these are insurance penetration rate, insurance density and gross premium while carbon footprint was measured as carbon dioxide emissions and aggregate greenhouse gas emissions.

In order to investigate the effects of insurance sector development and carbon footprint on economic growth in Sub-Saharan African countries, the models of Omoruyi-Aigbovo and Orobator (2023) and Obayagbona (2023) were adopted and modified in terms of variables included to proxy insurance sector development, carbon footprint, economic growth as well as the control variables introduced to account for other factors that have been found to influence economic growth. The models of Omoruyi-Aigbovo and Orobator (2023) and Obayagbona (2023) are therefore presented below; Omoruyi-Aigbovo and Orobator (2023) model the effect of insurance sector development on economic growth as follows:

$$LGDPGR_{it} = \beta_0 + \beta_1 LGPRIM_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8)$$

Where: $LGDPGR_{it}$ represents real GDP growth rate; $LGPRIM_{it}$ represents total sum of premium income from life and non-life insurance business; β_0 and β_1 are the corresponding coefficients; ε_{it} is the residual term; and i and t indicate the country and time, respectively.

Obayagbona (2023) Model the effect of carbon footprint on economic growth as follows:

$$GDPPC = \alpha_0 + \alpha_1 GHGe_t + \alpha_2 RENGC_t + \alpha_3 ELCON_t + \alpha_4 TOPN_t + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.9)$$

Where: RGDPP – GDP per capita income (a proxy for economic growth), GHGe – greenhouse gas emissions, RENGC – renewable energy consumption, ELCON – electricity consumption, TOPN – trade openness, u_t – the error term.

Based on the fact that in this study we employed different insurance sector development proxies and we utilize carbon dioxide emission as a proxy for carbon footprint in addition to the aggregate greenhouse gas emissions utilized by Obayagbona (2023); in terms of control variables this study include foreign direct investment and trade openness in our model, the above models are therefore modified to determine the link between insurance sector development, carbon footprint and economic growth in selected Sub-Saharan African Countries.

In the specification of the models for this study, four (4) panel regression models are specified. The first model, that is, model (3.10) and (3.11) examine the relationship between insurance sector development and economic growth for both the long-run and the short-run, while the second model that is model (3.12) and (3.13) examines the relationship between carbon footprint and economic growth for both long-run and the short-run. The third model that is model (3.14) and (3.15) examines the joint effect of insurance sector development and carbon footprint on economic growth for both the long-run and short-run. The fourth model that is model (3.16) and (3.17) examines the moderating effect of insurance sector development on the relationship between carbon footprint on economic growth for both the long-run and short-run in the selected Sub-Saharan African countries.

Model I: Insurance Sector Development and Economic Growth Model

The functional form of the model is stated thus:

$$RGDPG = f(IPR, IND, GIP, FDI, TOP, POLSTAB) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.10)$$

The panel data model is stated in econometric form and all the variables are transformed into natural logarithmic form, the estimated model is of the form:

$$\Delta lnRGDPG_{it} = \beta_0 + \beta_1 lnRGDPG_{it-1} + \beta_2 lnIPR_{it} + \beta_3 lnIND_{it} + \beta_4 lnGIP_{it} + \beta_5 lnFDI_{it} + \beta_6 lnTOP_{it} + \sum_{i=1}^{J} \alpha_1 \Delta lnRGDPG_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnIPR_{it-1} + \sum_{i=1}^{p} \alpha_3 lnIND_{it-1} + \sum_{i=1}^{p} \alpha_4 lnGIP_{it-1} + \sum_{i=1}^{r} \alpha_5 \Delta lnFDI_{it-1} + \sum_{i=1}^{s} \alpha_6 \Delta lnTOP_{it-1} + \sum_{i=1}^{x} \alpha_{15} \Delta lnPOLSTAB_{it-1} + \varepsilon_{it} \ldots\ldots\ldots \quad (3.11)$$

Model II: Carbon Footprint and Economic Growth Model

The functional form of the model is stated thus:

$$RGDPG = f(CO2, AGHG,\ FDI, TOP, POLSTAB) \ldots\ldots\ldots \quad (3.12)$$

The panel data model is stated in econometric form and all the variables are transformed into natural logarithmic form, the estimated model is of the form:

$$\Delta lnRGDPG_{it} = \beta_0 + \beta_1 lnRGDPG_{it-1} + \beta_2 lnCO2_{it} + \beta_3 lnAGHG_{it} + \beta_4 lnFDI_{it} + \beta_5 lnTOP_{it} + \sum_{i=1}^{J} \alpha_1 \Delta lnRGDPG_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnCO2_{it-1} + \sum_{i=1}^{p} \alpha_3 lnAGHG_{it-1} + \sum_{i=1}^{r} \alpha_4 \Delta lnFDI_{it-1} + \sum_{i=1}^{s} \alpha_5 \Delta lnTOP_{it-1} + \sum_{i=1}^{x} \alpha_{15} \Delta lnPOLSTAB_{it-1} + \varepsilon_{it} \quad (3.13)$$

Model III: Insurance Sector Development, Carbon Footprint and Economic Growth Model

The functional form of the model is stated thus:

$$RGDPG = f(IPR, IND, GIP, CO2, AGHG, FDI, TOP) \ldots\ldots\ldots \quad (3.14)$$

The panel data model is stated in econometric form and all the variables are transformed into natural logarithmic form, the estimated model is of the form:

$$\Delta lnRGDP_{it} = \beta_0 + \beta_1 lnRGDPG_{it-1} + \beta_2 lnIPR_{it} + \beta_3 lnIND_{it} + \beta_4 lnGIP_{it} + \beta_5 lnCO2_{it} + \beta_6 lnAGHG_{it} + \beta_7 lnFDI_{it} + \beta_8 lnTOP_{it} + \sum_{i=1}^{J} \alpha_1 \Delta lnRGDPG_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnIPR_{it-1} + \sum_{i=1}^{p} \alpha_3 lnIND_{it-1} + \sum_{i=1}^{r} \alpha_4 \Delta lnGIP_{it-1} + \sum_{i=1}^{s} \alpha_5 \Delta lnCO2_{it-1} + \sum_{i=1}^{v} \alpha_6 \Delta lnAGHG_{it-1} + \sum_{i=1}^{w} \alpha_7 \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \alpha_8 \Delta lnTOP_{it-1} + \sum_{i=1}^{x} \alpha_{15} \Delta lnPOLSTAB_{it-1} + \varepsilon_{it} \quad (3.15)$$

Model IV: Moderating Effect of Insurance Sector Development Variables on the Relationship between Carbon Footprint and Economic Growth Model

According to Cohen, Cohen, Leon and West (2003), the moderating variable is identified statistically as an interaction, which means a qualitative or quantitative variable that influence the trend and/or the strength of the relationship between explanatory variable and respond variable. Cohen, et al.,(2003), further stated that the moderating effect is identified when the moderating variable Z influence the relationship's strength between the independent variable X and the dependent variable Y.

The functional form of the model is stated thus:

$$RGDPG = f(IPR, IND, GIP, CO2, AGHG, IPR * CO2, IND * CO2, GIP * CO2, IPR * AGHG, IND * AGHG, GIP * AGHG, FDI, TOP, POLSTAB) \ldots\ldots\ldots\ldots (3.16)$$

The panel data model is stated in econometric form and all the variables are transformed into natural logarithmic form, the estimated model is of the form:

$$
\begin{aligned}
\Delta lnRGDPG_{it} = {} & \beta_0 + \beta_1 lnGRDPG_{it-1} + \beta_2 lnIPR_{it} + \beta_3 lnIND_{it} + \beta_4 lnGIP_{it} + \beta_5 lnCO2_{it} \\
& + \beta_6 lnAGHG_{it} + \beta_7 lnIPR_{it} * lnCO2_{it} + \beta_8 lnIND_{it} * lnCO2_{it} + \beta_9 lnGIP_{it} \\
& * lnCO2_{it} + \beta_{10} lnIPR_{it} * lnAGHG_{it} + \beta_{11} lnIND_{it} * lnAGHG_{it} \\
& + \beta_{12} lnGIP_{it} * lnAGHG_{it} + \beta_{13} lnFDI_{it} + \beta_{14} lnTOP_{it} \\
& + \sum_{i=1}^{J} \alpha_1 \Delta lnRGDPG_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnIPR_{it-1} + \sum_{i=1}^{p} \alpha_3 lnIND_{it-1} \\
& + \sum_{i=1}^{r} \alpha_4 \Delta lnGIP_{it-1} + \sum_{i=1}^{s} \alpha_5 \Delta lnCO2_{it-1} + \sum_{i=1}^{v} \alpha_6 \Delta lnAGHG_{it-1} \\
& + \sum_{i=1}^{m} \alpha_7 \Delta lnIPR_{it-1} * lnCO2_{it-1} + \sum_{i=1}^{p} \alpha_8 lnIND_{it-1} * lnCO2_{it-1} \\
& + \sum_{i=1}^{r} \alpha_9 \Delta lnGIP_{it-1} * lnCO2_{it-1} + \sum_{i=1}^{s} \alpha_{10} \Delta lnIPR_{it-1} * lnAGHG_{it-1} \\
& + \sum_{i=1}^{v} \alpha_{11} \Delta lnIND_{it-1} * lnAGHG_{it-1} + \sum_{i=1}^{v} \alpha_{12} \Delta lnGIP_{it-1} * lnAGHG_{it-1} \\
& + \sum_{i=1}^{w} \alpha_{13} \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \alpha_{14} \Delta lnTOP_{it-1} + \sum_{i=1}^{x} \alpha_{15} \Delta lnPOLSTAB_{it-1} \\
& + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ldots (3.17)
\end{aligned}
$$

Where;

Country and time period are denoted by 〖Subscript〗 (i) and t, respectively.

The short-run maximum delays for the variables are j, m, p, r, s, v, w and x; optimum lags are determined by information criteria.

β_0 = constant term, equal the value of Y when the value of X = 0

β and α = coefficients of the parameters

The parameters β_1, β_2 β_3 β_4, β_5, β_6, β_7, β_8 β_9 β_{10}, β_{11}, β_{12}, β_{13},and β_{14} are the long-run impact of the independent variables while α_1, α_2 α_3 α_4, α_5 α_6 α_7, α_8 α_9 α_{10}, α_{11} α_{12} α_{13}, and α_{14} are respectively the short-run impacts of the these variables.

$lnRGDPG_{it}$ = Real Gross domestic product growth rate in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnRGDPG_{it-1}$ = Lagged value of real gross domestic product growth rate in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnIPR_{it}$ = Insurance penetration rate in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnIPR_{it-1}$ = Lagged value of insurance penetration rate in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnIND_{it}$ = Insurance density in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnIND_{it-1}$ = Lagged value of insurance density in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnGIP_{it}$ = Gross premium in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnGIP_{it-1}$ = Lagged value of gross premium in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnCO2_{it}$ = Carbon dioxide emissions in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnCO2_{it-1}$ = Lagged value of carbon dioxide emissions in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnAGHG_{it}$ = Aggregate greenhouse gas in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnAGHG_{it-1}$ = Lagged value of aggregate greenhouse gas in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnFDI_{it}$ = Foreign direct investment in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnFDI_{it-1}$ = Lagged value of foreign direct investment in natural logarithm form in the individual SSA countries (*i*) in a given period (*t*).

$lnTOP_{it}$ = Trade openness in the individual SSA countries (*i*) in a given period (*t*).

$lnTOP_{it-1}$ = Lagged value of trade openness in the individual SSA countries (*i*) in a given period (*t*).

$lnIPR * CO2, lnIND * CO2, lnGIP * CO2, lnIPR * AGHG, lnIND * AGHG, lnGIP * AGHG =$ are the interaction term between insurance sector development variables (IPR, IND, GIP) and the carbon footprint variables (CO2, AGHG) in the individual SSA countries (i) in a given period (t).

ε_{it} = error term or stochastic variables.

The variables of this study are in logarithm form to allow the coefficients to be interpreted as rate of change of variables in elasticity form. Carbon footprint (carbon dioxide emission and aggregate greenhouse gas emissions) and economic growth (gross domestic product per capita) relationship are consistent with the EKC hypothesis if the long-run income elasticity of RGDPG is negative while the short-run income elasticity is positive. Alternatively, if the Long-run income elasticity is smaller than the Short-run income elasticity then an inverted-U relationship between carbon footprint (carbon dioxide emission and aggregate green house) and economic growth (gross domestic product per capita) exists (Narayan & Narayan, 2010). If this condition holds, then the EKC hypothesis is accepted and an inverted-U relationship exists. Long-run relationship between economic growth and carbon footprint is negative, because the development of new low-carbon technologies enables reaching in the long-run the same production level at lower CO_2 emissions. Short-run relationship between economic growth and CO_2 emissions is positive, because fast increase in production can be reached due to more intensive energy use by the existing technologies, then the capacity increases as well the CO_2 emissions

The a *priori* expectations of the signs of the explanatory variables are given as: $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 > 0$, $\beta_5 > 0$, $\beta_6 > 0$; $\beta_1 > 0$, $\beta_2 > 0$ or < 0, $\beta_3 > 0$ or < 0, $\beta_4 > 0$, $\beta_5 > 0$; $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 > 0$, $\beta_5 > 0$ or < 0, $\beta_6 > 0$ or < 0, $\beta_7 > 0$, $\beta_8 > 0$.

$\beta_0 - \beta_6$; $\beta_0 - \beta_5$, $\beta_0 - \beta_8$ and $\beta_0 - \beta_{14}$ for the four models, that is model (3.11), (3.13), (3.15) and (3.17) are coefficients of the parameters to be estimated.

In other words, theoretically, it is expected that a period lagged real GDP is positively related to current period's real GDP. Insurance sector development indicators (insurance premium rate, insurance density and gross premium) are expected to have a positive impact on economic growth (real GDP growth rate). For carbon footprint, a priori expectation is that in the short-run, carbon footprint is expected to have positive impact on economic growth while in the long-run carbon footprint is expected to have negative impact on economic growth. For the control variables (foreign direct investment, trade openness and political stability), the a priori expectation is that a rise in foreign direct investment and trade openness will increase economic growth.

Model V: Granger Causality between Insurance Sector Development and Economic Growth Model

In order to investigate the direction of causation between the specific variables representing insurance sector development, carbon footprint and economic growth in Sub-Saharan African countries, the study adapts the causality model originally developed by Granger (1969) within a Panel Causality framework. Granger (1969) proposed that if causal relationship exists between variables, these variables can be used to predict each other. The author pointed out that in causality approach, a variable say Y, is caused by X if Y can be predicted better from past values of Y and X than from past values of Y alone. The causality procedure helps to ascertain whether a uni-directional or bi-directional (feedback) relationship exists between insurance sector development and economic growth as well as between carbon footprint and economic growth in Sub-Saharan Africa countries.

Our choice for the panel causality procedure is because it consists of the more powerful and simpler way of testing causal relationship. In order to carry out the causality test, the following multi- variate model was estimated:

$$Y_{it} = \beta_0 + \sum_{k=1}^{m} \beta_k Y_{it-k} + \sum_{l=1}^{n} \alpha_j X_{it-j} + u_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots. (3.18)$$

$$X_{it} = \gamma_0 + \sum_{k=1}^{m} \delta_k X_{it-k} + \sum_{l=1}^{n} \varphi_j Y_{it-j} + \vartheta_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.19)$$

Where:

Y_i = economic growth variable (real gross domestic product per capita) in Sub-Saharan Africa countries.

X_i = Insurance sector development or carbon footprint variables in Sub-Saharan Africa countries

Thus, several pairs of relationships was determined from the causality test, while focusing on insurance sector development and carbon footprint variables against economic growth variable.

u_t and ϑ_t = mutually uncorrelated error terms (i.e. zero mean white noise error terms).

'k' and 'j' = the number of lags.

The null hypothesis is $\alpha_j = 0$ for all j's and $\delta_k = 0$ for all k's versus the alternative hypothesis that $\alpha_j \neq 0$ and $\delta_k \neq 0$ for at least some of the j's and k's. If the coefficients α_j's are statistically significant but δ_k's are not, then insurance sector development or carbon footprint granger causes economic growth. In the reverse case, economic growth granger causes insurance sector development or carbon footprint in Sub-Saharan Africa countries. If both α_j and δ_k are significant, for each pairs of variables, then causality runs both ways (feedback effect).

There are three different types of situation in which a Granger-causality test can be applied: First, in a simple Granger-causality procedure where there are two variables and their lags. Second, in a multivariate Granger-causality technique where more than two variables are included, because it is supposed that more than one variable can influence the results. And finally, Granger-causality can also be tested in a VAR framework; in this case the multivariate model is extended in order to test for the simultaneity of all included variables. The empirical results to be presented in this study was estimated following the second scenario above, specifically, using a multivariate panel causality technique in order to test the direction of causation between economic growth and insurance sector development variables as well as between economic growth and carbon footprint variable.

3.8 Measurement of Variables

Variables	**Variable Type**	**Measurement**	***A-priori* Expectation**	**Previous Study that Utilized the Variable**
Real Gross Domestic Product Growth Rate (RGDP)	Dependent	Measured as the annual change in real GDP: GDPt-GDPt - 1)/GDPt – 1		Oloyede et al., (2023)
Insurance Penetration Rate (IPR)	Dependent	Measure as total insurance premiums as a percentage of its gross domestic product (GDP)	(+)	Aigbovo and Iroh (2021)
Insurance Density (IND)	Independent	Calculated by dividing the total insurance premium by the population	(+)	Ul Din, Abu-Bakar and Regupathi (2017)
Gross Premium (GIP)	Independent	Measured as the logarithm of gross premium written by the insurance industry in a country	(+)	Omoruyi-Aigbovo and Osamwonyi (2022)
Carbon Dioxide Emission	Independent\`	Carbon emission (metric tons per capita (kt)	(-) (+)	Omoruyi - Aigbovo and Aigbovo, (2023)

(CO_2)				
Aggregate Greenhouse Gas Emission (AGHG)	Independe nt	Aggregate GHG emissions (inclusive of forest, land use, kilotonne of CO_2 equivalent), etc.	(-) (+)	Obayagbona (2023)
Foreign Direct Investment (FDI)	Control	Calculated as the ratio of foreign direct investments (FDI) to GDP, or the net inflows of investment divided by GDP	(+)	Mesagan (2015)
Trade Openness (TOP)	Control	Calculated as the ratio of trade (imports and exports) to GDP	(+)	Obayagbona (2023)
Institutional Quality	POLSTAB	Proxied by political stability index (ranging between +2.5 and -2.5)	(+)	Oloyede et al., (2023)

Source: *Author's compilation* (2025)

3.9 Data Estimation Techniques

For the panel analysis in this study, the Mean Group (MG) and the Pooled Mean Group (PMG) was used to evaluate the long- and short-term relationships among the variables. Using the Autoregressive Distributed Lags (ARDL) approach, this study further assess the long-run and short-run connection among the variables for specific nations. Understanding the dynamic impact of insurance sector development and carbon footprint on economic growth throughout the sample countries requires this. To accurately characterise the nature of our data, we also conducted correlation analysis and descriptive statistics in this study.

As a preliminary step to the estimation of the empirical model it is necessary to evaluate whether the series are stationary, which involves using a panel unit root test. We applied one of the most commonly used test procedures proposed by Im, Pesaran and Shin (2003), henceforth IPS, which consists of a generalization of time series unit root tests to panel data. The IPS test assumes that all series are non-stationary under the null hypothesis but allows for heterogeneity in the autoregressive coefficient, which is assumed to change freely among the countries. The next step involves testing for panel cointegration in order to ensure that there is a long run relationship between the variables that define the empirical model, which is a key issue for the consistency of the PMG estimator given that the variables are non-stationary. Pedroni (1999, 2001) proposed a residual-based test that assumes a single cointegrating vector but allows the coefficients of each cointegration relation to differ among countries. Seven different statistics to test panel data cointegration are available [panel v-statistics, panel t-statistics (non-parametric), panel ρ-statistics, the panel t-statistics (parametric), the group ρ-statistics, the group t-statistics (non-parametric) and the group statistics (parametric)]. The first four are based on pooling and the other three on the between dimension. *Eviews* 13 software was used to conduct all data analysis.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

In this chapter, attention is devoted to the presentation, analysis, and interpretation of the data and the empirical models employed in the study. The estimation results are organized in accordance with the specific objectives of the research. A combination of statistical and econometric methods is utilised to provide a robust analytical foundation. The chapter begins with descriptive statistics - including tables, charts, and correlation analysis – to outline the basic characteristics of the dataset. These descriptive tools help to reveal initial patterns, trends, and co-movements among the variables, thereby offering a preliminary background for subsequent inferential analysis.

Econometric evaluation is then carried out in alignment with the study's objectives. A dynamic empirical framework is adopted, with the Pooled Mean Group (PMG) estimator, which is a panel extension of the Autoregressive Distributed Lag (ARDL) approach, is employed for the main econometric analysis. Several estimation procedures and hypothesis tests are conducted to address different aspects of the study. Specifically, the set of instruments used to examine the relationship between greenhouse gas (GHG) emissions and the explanatory variables differs from those applied in testing the Kuznets Curve hypothesis. Furthermore, prior to estimation, the datasets are assessed for their time series and cross-sectional properties to ensure the appropriateness of the econometric techniques utilised.

4.2 Data Presentation

Data used for the study is presented in Table 1, Appendix I.

4.3 Descriptive Statistics

Table 4.1 provides key descriptive statistics for variables used in the study. The variables can be categorised into components of insurance development (penetration, density, premiums), environmental indicators (carbon dioxide emissions, greenhouse gases), and economic growth in Sub-Saharan African (SSA). Average real GDP growth rate is 4.48 percent for the period suggesting generally positive economic growth over the years for the countries. Compared to historical standards, this is a moderate to high growth rate for the SSA region. Maximum growth rate is 15.84 percent while minimum growth rate is negative at -20.81 percent. The wide range in growth rates suggests high volatility in GDP growth. This is confirmed by the generally high standard deviation of 3.67. The growth rate deviates from the mean by ±3.67% on average, indicating significant variability in economic performance for the region. The variable is negatively skewed at -1.44, indicating that more extreme negative growth episodes (like deep recessions) pull the tail to the left. The value of the Kurtosis (11.67) also confirms this. The Jarque-Bera value is significant at 1 percent level which strongly rejects the null hypothesis of normality. This shows that there is heavy heterogeneity among the dataset. This also justifies the application of the panel-based ARDL framework for the analysis.

Average insurance penetration Rate (IPR) is 0.83 percent which is low and typical of SSA's underdeveloped insurance markets over the years. The standard deviation is lower than the average score which indicates that the low insurance penetration rate is similar across all the SSA countries. The high skewness of 1.57 however suggests that a few countries (e.g., South Africa, Namibia) have significantly higher penetration (maximum is 3.02 percent) compared to the regional average. Essentially, low insurance penetration (IPR) may limit climate resilience. Average insurance density (IND) is $2.86 with a standard deviation of 4.51 and a maximum of

$21.33. The scores reflect low per capita insurance spending in the region, although the maximum and standard deviations indicate extreme disparities. For instance, there are possible disparities between affluent urban and rural populations and between countries.

Average gross insurance premium to GDP rate (GIP) is 8.09 percent of GDP which also shows a modest contribution to GDP. The skewness of 2.34 indicates that premiums are more concentrated in a few countries. From the description of the insurance development variables, it is seen that while both IPR and IND show right-skewed, non-normal distributions with outliers, IND exhibits far greater variability and extreme values than IPR. This suggests that disparities in per capita insurance spending across SSA are much larger than differences in insurance penetration rates. This reveals the uneven nature of the development of the insurance markets and income disparities across the region.

Table 4.1: Descriptive Statistics

Variable	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	J-B
IPR	0.83	3.02	0.13	0.59	1.57	5.20	268.87
IND	2.856	21.334	0.74	4.51	2.19	7.13	661.48
GIP	8.09	63.25	0.34	13.63	2.34	7.98	849.12
CO_2	1.15	9.55	0.06	1.85	3.01	11.90	2102.81
GHG	0.37	1.68	0.11	0.27	3.16	13.39	2693.10
FDI	2.83	24.01	-10.04	3.38	1.40	9.65	946.98
TOP	63.49	128.05	20.72	24.70	0.68	2.54	37.06
POLSTAB	-0.31	1.22	-2.26	0.85	-0.17	2.25	12.36
RGDPG	4.48	15.84	-20.81	3.67	-1.44	11.67	1520.16

Source: Author’s computations (2025) using Eviews 13.

For the environmental and carbon emission variables, average CO_2 emissions per capita (CO_2) is 1.15 metric tons. This amount is essentially low compared to global averages reaching u to 2.7 metric tons (IMF, 2024). Maximum emission per capita is 9.55 metric tons which is attained by the more industrial and oil producing countries. The high skewness of 3.01 as well as Kurtosis of 11.90 reveals that emissions are heavily right-skewed, with extreme outliers. Average greenhouse gas emission (GHG) is also low at 0.37 percent of GDP with a standard deviation of 0.27 percent which is lower than the mean value. This shows that GHG is generally low among the countries. The skewness of 3.16 also shows that a few high-emission countries dominate the distribution.

For the control variables, average FDI inflow is 2.83 percent of GDP which is moderate inflows, although the minimum of -10.04 percent suggests significant capital flight in some countries. As is expected, the Kurtosis of 9.65 is quite high and indicates volatile FDI trends which may be likely tied to commodity prices/political instability in the SSA region. Trade openness (TOP) is at 63.49 percent on average which is slightly high and indicates serious integration into global trade for the region. Some countries had up to 128.05 percent of TOP (e.g., small, trade-dependent economies like Seychelles). Average score for political stability (POLSTAB) is -0.31. This is negative score that reflects widespread political instability in the region.

Table 4.2 shows the mean values for the major variables in the study for each of the countries. It is seen that Nigeria (12.82) and South Africa (12.64) have the highest real GDP values. These are the two largest economies in the region. Niger (8.99) and Togo (8.51) have the smallest values and they are smaller and less industrialized economies. Carbon dioxide emissions (CO_2) are highest for South Africa (3.12 percent), Mauritius (2.85 percent) and Botswana (2.57 percent). This shows that perhaps these are the countries with higher industrialization and energy use. For instance, South Africa uses a high level of coal for electricity. Niger (0.09 percent), Uganda (0.12 percent) and Burkina Faso (0.16 percent) have the lowest carbon emission per capita. In terms of the insurance market development, Namibia (1.84 percent), South Africa (2.41 percent) and Mauritius (1.46 percent) have the highest insurance penetration rate. This shows that these are the mature financial sectors in the region. Interestingly, Nigeria at 0.26 percent has the lowest insurance penetration rate in the region. South Africa at 15.02 USD also leads in terms of insurance density. While Mauritius and Namibia follow closely. On the other hand, Niger, Uganda and Burkina Faso each has insurance density of less than one dollar. Notice that South Africa's IND is 84 times higher than Niger's, showing extreme inequality in insurance access among SSA countries. Average gross premiums/GDP is also highest for South Africa at 49.45 percent while it is lowest for Niger at 0.65 percent.

Table 4.2: Individual Countries Descriptive Statistics

Country	RGDP	CO_2	IPR	IND	GIP
Angola	11.09	0.92	0.56	1.33	1.81
Benin	9.22	0.46	0.35	0.33	1.47
Botswana	9.43	2.57	0.86	5.09	15.96
Burkina Faso	9.19	0.16	0.44	0.28	1.68
Cabo Verde	7.34	1.43	1.32	4.29	2.43
Cameroon	10.22	0.38	0.56	0.75	1.71
Cote d'Ivoire	10.59	0.39	0.62	1.01	2.42
Ghana	10.57	0.50	0.44	0.66	1.48
Kenya	10.99	0.32	1.20	1.39	6.72
Mauritius	9.23	2.85	1.46	11.74	22.94
Namibia	9.09	1.46	1.84	7.71	33.46
Niger	8.99	0.09	0.41	0.18	0.65
Nigeria	12.82	0.64	0.26	0.45	1.01
Senegal	9.68	0.57	0.66	0.80	2.57
South Africa	12.64	3.12	2.41	15.02	49.45
Tanzania	10.54	0.20	0.44	0.34	0.78
Togo	8.51	0.26	0.73	0.52	2.95
Uganda	10.15	0.12	0.36	0.23	0.98
Zambia	9.69	0.28	0.76	0.85	1.28

Source: Author's computations (2025) using Eviews 13.

Table 4.2 shows clear income-insurance correlation where wealthier economies (South Africa, Mauritius, Botswana) have higher insurance penetration. This suggests that there may be more demand for risk management in richer countries. Poorer nations like Niger and Togo tend to lack access to formal insurance. It is also seen that carbon emissions are related to development. Countries with higher CO_2 are also the more industrialised while low CO_2 emitters are the more agrarian but also energy-poor ones. The SSA regional leaders in insurance is clearly South Africa which dominates in insurance all development indicators. This can be linked to the country's advanced financial sector. Nigeria lags in insurance (IPR of 0.26 percent) despite its large economy. This may reveal significant untapped potential in the insurance sector.

The correlation matrix which shows initial patterns of relationships among the variables is presented in Table 4.3. The insurance sector indicators, including insurance penetration (IPR), insurance density (IND), and gross insurance premiums (GIP) all exhibit strong positive intercorrelations (above 0.78) among themselves. This shows that there is a closely linked insurance market structure among the SSA countries. Given that the correlations among the variables are higher than 0.7, there is the need to account for multicollinearity in subsequent regression models. Hence, the models are estimated in a recursive manner where each of the variables is included per model. However, their individual correlations with economic growth (LRGDP) are modest, with GIP showing the strongest positive association (0.226), followed by IND (0.141), while IPR appears weakly correlated (0.028).

Table 4.3: Correlation Matrix

Variable	LRGDP	IPR	IND	GIP	CO_2PC	GHGN	FDI	TOP	POLSTAB
LRGDP	1								
IPR	0.028 (0.550)	1							
IND	0.141 (0.003)	0.686 (0.000)	1						
GIP	0.226) (0.000	0.704 (0.000)	0.703 (0.000	1					
CO_2	0.339 (0.000)	0.676) (0.000)	0.685) (0.000)	0.684 (0.000)	1				
GHG	0.323 (0.000)	0.645 (0.000)	0.643 (0.000)	0.694 (0.000)	0.705 (0.000)	1			
FDI	-0.256 (0.000)	0.158 (0.001)	0.066 (0.159)	0.045 (0.340)	-0.026 (0.585)	-0.017 (0.715)	1		
TOP	-0.366 (0.000)	0.437 (0.000)	0.439 (0.000)	0.327 (0.000)	0.235 (0.000)	0.100 (0.033)	0.281 (0.000)	1	
POLSTAB	-0.533 (0.000)	0.392 (0.000)	0.439 (0.000)	0.343 (0.000)	0.300 (0.000	0.199 (0.000)	0.157 (0.001)	0.626 (0.000)	1

Source: Author's computations (2025) using Eviews 13.

The two environmental variables of carbon emissions per capita (CO_2) and greenhouse gas emissions (GHGN) are highly positively correlated at 0.694. This shows that emissions are critically reflected in greenhouse gases. The emissions variables also correlate positively with GDP (0.339 and 0.323, respectively), reflecting the emissions-growth trade-off typical in industrializing economies. Interestingly, trade openness (TOP) and foreign direct investment (FDI) show negative correlations with GDP (–0.366 and –0.256), possibly indicating structural vulnerabilities or import dependence within the sample. Political stability (POLSTAB) is negatively associated with GDP (–0.533), suggesting a potential tension between growth and governance in the region.

The description of the dataset further involves presenting the scatterplots for the relationships. This scatterplot in Fig. 4.1 illustrates the relationship between insurance penetration rate (IPR) and insurance density (IND) across various Sub-Saharan African countries. The plot reveals a strong positive linear relationship between these two insurance development indicators, as evidenced by the high R^2 value of 0.7865. The trend line equation ($y = 2.1009x + 5.1829$) indicates that for each average 1 percent increase in insurance penetration, insurance premium rises by 2.1 percentage points. This strong correlation suggests that countries with higher insurance penetration relative to GDP also tend to have higher per capita insurance spending.

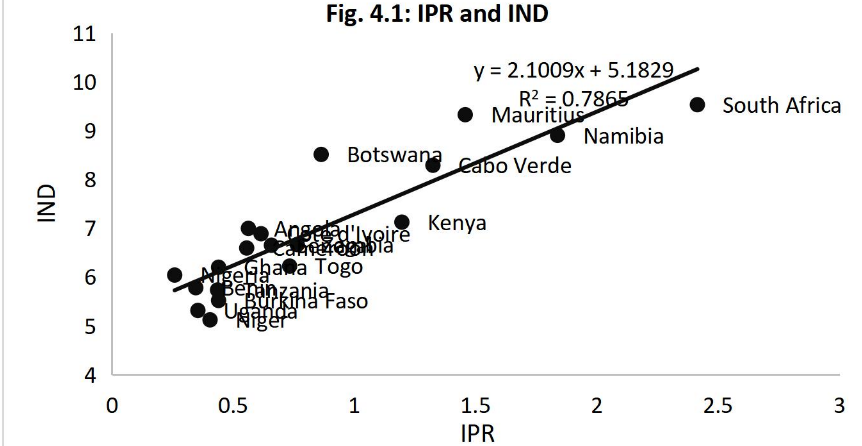


Fig. 4.1: IPR and IND

Figure 4.2 displays the relationship between gross insurance premium (GIP) and insurance density (IND) across the selected Sub-Saharan African countries. The plot shows a non-linear relationship between insurance premium rates and insurance density. The fitted curve is quadratic ($y = 3.4464x^2 - 42.659x + 132.11$), indicating a nonlinear, upward-sloping relationship between GIP and IND. As GIP increases, IND rises slowly at first, then accelerates sharply for higher GIP values. At lower density, insurance premium is low among the countries. But at higher levels of density in the insurance market, premiums tend to rise sharply. The scatterplot highlights substantial heterogeneity in insurance market development across SSA. Countries with higher gross insurance premiums tend to have disproportionately higher per capita insurance spending, especially as they move beyond a certain GIP threshold. This suggests increasing returns to scale or market maturity effects in the insurance sector for countries further along the development path.

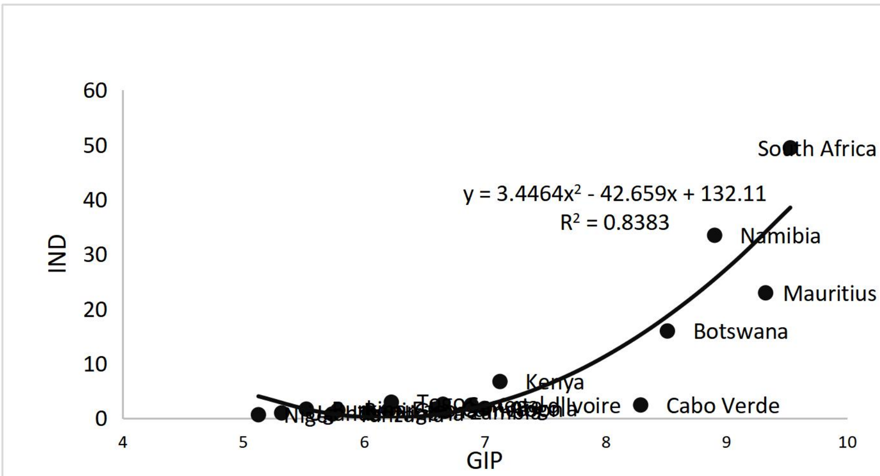


Fig. 4.2: GIP and IND

Figure 4.3 shows the relationship between CO_2 and GHG which is non-linear in nature. At lower levels of CO_2 emission FGF rises. After a threshold however, increase CO_2 emission are likely to lead to lower GHG. This is an interesting outcome.

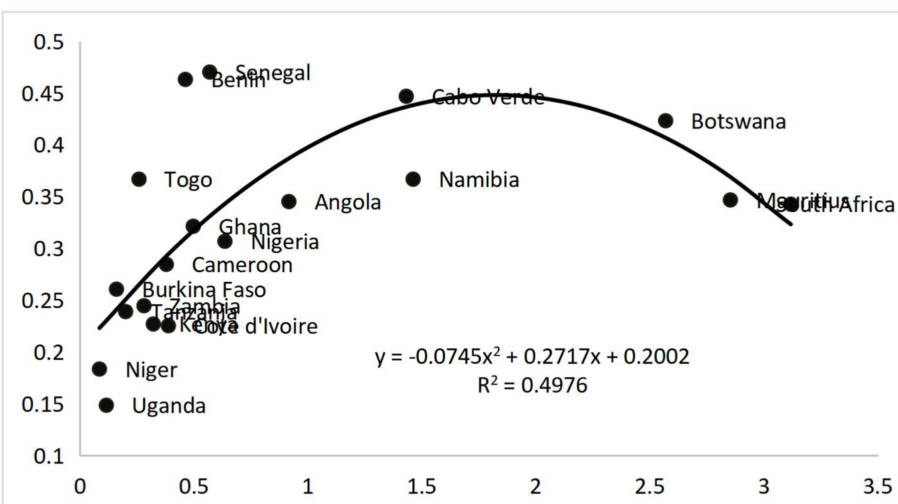


Fig. 4.3: CO_2 and GHG

4.4 Tests of Time Series and Cross-sectional Properties of the Panel Data

4.4.1 Test for Normality

In this section, we present the cross-sectional characteristics of our data to assess its suitability for analysis. Figure 4.4 displays the Kernel density tests for normality across all variables. Properly normally distributed variables would exhibit smooth, bell-shaped density functions concentrated at the center of the plot. However, our examination reveals that none of the variables demonstrates normal distribution-the kernel plots are predominantly skewed away from the center and show considerable dispersion. This non-normality is anticipated given our dataset's composition, which pools observations from different banks across multiple time periods. Consequently, Ordinary Least Squares (OLS) estimation would be inappropriate for our analysis. Instead, a panel-based estimation framework is more suitable to address the cross-sectional heterogeneity present in our data.

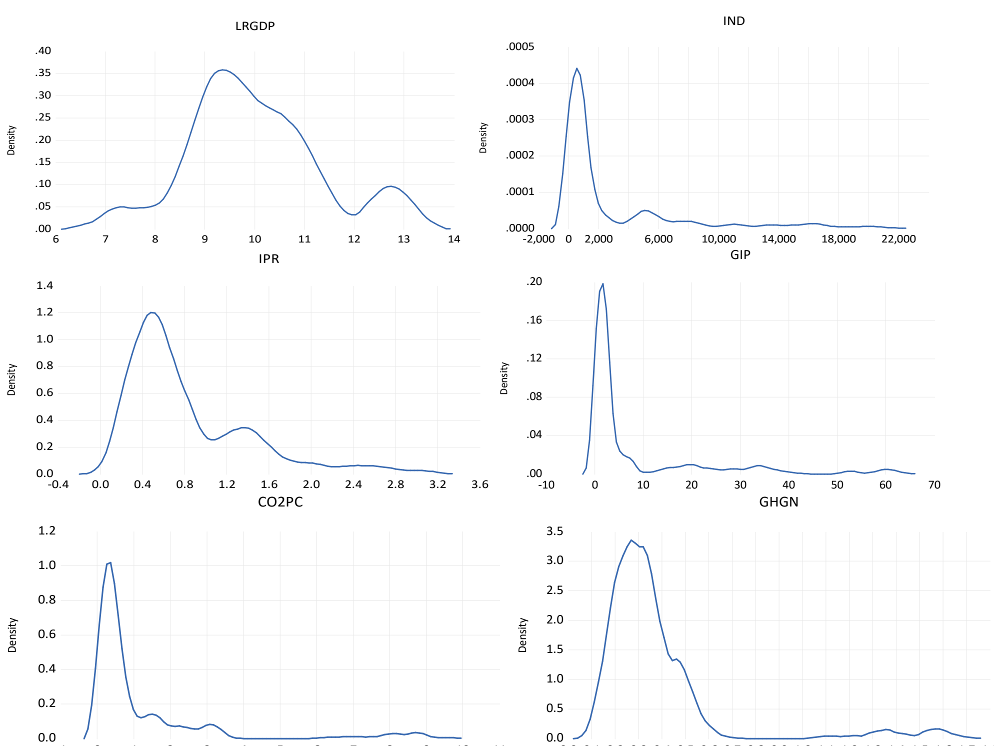


Fig. 4.4: The Quantile-Quantile Plots for Variables

Source: Author’s computations (2025) using Eview13.

4.4.2 Panel Unit Root Test

As shown in the descriptive statistics, the countries included in the empirical analysis exhibit considerable heterogeneity in terms of environmental degradation and insurance sector development, as reflected in the descriptive statistics. This diversity suggests that the panel data used likely contain both country-specific (individual heterogeneity) and common (homogeneous) characteristics. Therefore, it is essential to apply panel unit root tests that account for these dual influences to assess the stationarity properties of the data accurately. In this study, the Levin, Lin and Chu (LLC) test was employed to examine stationarity under the assumption of a homogeneous panel, which presumes identical cointegration vectors across countries. However, recognizing that each country may differ in emissions patterns-particularly due to variations in institutional quality and outcomes-the analysis also incorporates heterogeneous panel unit root tests, specifically the Im, Pesaran and Shin (IPS) test and the Augmented Dickey-Fuller (ADF) test. These tests allow for individual heterogeneity in the autoregressive coefficients. Unit root tests were conducted on the variables both in their levels and first differences. The results for the variables in levels are presented in Table 4.4 below. This approach ensures a robust examination of the stationarity properties, accounting for both common and country-specific dynamics within the panel data.

Table 4.4: Panel Unit Root Test Results

Variables	Homogeneous Unit Root Process		Heterogeneous Unit Root Process			
	Level	1st Diff	Level		1st Diff	
	LLC	LLC	IPS	ADF-Fisher	IPS	ADF-Fisher
LRGDP	-1.037	-5.079**	1.689	49.59	-5.579**	100.4**
IPR	-0.563	-8.618**	-0.956	45.86	-10.78**	-8.619**
IND	-1.89	-5.44**	-2.1	14.7	-5.95**	191.9*
GIP	-3.08	-7.14**	-0.81	92.08	-9.35**	252.1**
CO_2	-1.28	-6.68*	-0.66	24.46	-8.20**	228.8**
GHGN	-4.281**	-6.048**	2.703**	73.84**	-8.993**	152.3**
FDI	-1.241	-11.84**	-0.43	19.62	-10.06**	259.0**
TOP	-2.221*	-9.46**	-1.756*	45.51	-8.241**	187.5**
POLSTAB	-2.974**	-10.75**	-3.257**	-90.91**	-12.45**	213.5**

Source: Author's computations (2025) using Eviews 13.

The panel unit root tests reveal that the majority of the variables in the study (including LRGDP, IPR, IND, GIP, CO_2 emissions, GHGN, and FDI) are non-stationary at their levels but become stationary after first differencing. This shows that these variables are integrated of order one (I(1)). This conclusion is consistently supported by both the homogeneous (LLC) and heterogeneous (IPS, ADF-Fisher) tests. An exception is observed in the cases of trade openness (TOP) and political stability (POLSTAB), which are both stationary at level. There is therefore indication that these variables are stationary at levels I(0) process. These results validate the application of dynamic panel estimation techniques, such as the Pooled Mean Group (PMG) estimator. This method accounts for the combination of stationary and non-stationary panel variables while also capturing potential long-run equilibrium relationships.

Given that the variables in the study are cross-sectionally dependent, there is need to further test the stationarity status of the variables using a second-generation procedure. The result of the Bai and Ng second-generation test for unit roots is presented in Table 4.5. The Bai and Ng test typically provides test statistics for both the common factors and the idiosyncratic components. The Bai and Ng test helps determine if a panel data series is stationary by examining the stationarity of its common and individual components (Stock & Watson, 2020). If both components are stationary, the series is considered stationary; otherwise, it may have a unit root and be non-stationary. The test accounts for potential cross-sectional dependence in the data.

In the result, the test statistic for the common factors (α_m) is not significant for all the variables except for IND, GIP, GHG FDI, TOP and POLSTAB. This implies that the null hypothesis of a unit root in the common factors is rejected for these variables at levels. This suggests the common factors for the variables are stationary. For RGDP, IPR and CO_2, the levels variables pass the significance test at the 5 percent level. Thus, the null hypothesis is not rejected. The results of the idiosyncratic components (ρ_i) also support the common factors results. By rejecting the null hypothesis for both the common and idiosyncratic components for IND, GIP, GHG FDI, TOP and POLSTAB variables, this shows that the variables are stationary in levels. While for RGDP, IPR and CO_2, they are not stationary in levels. The test for the first differences from both the common factor and idiosyncratic components shows that RGDP, IPR and CO_2 are actually stationary after first difference. Hence, they are I(1).

Table 4.5: Result for Bai and Ng second-generation test

Variable	Null hypothesis	Levels		First difference		
		Statistic	p-value (5%)	Statistic	p-value (5%)	Remark
RGDP	$\alpha_m = 1$	73.26	0.00	6.464	0.878	I(1)
	$\rho_i = 1$	5.583	0.00	0.735	0.328	
IPR	$\alpha_m = 1$	83.831	0.000	13.462	0.243	I(1)
	$\rho_i = 1$	5.642	0.000	0.456	0.873	
IND	$\alpha_m = 1$	0.363	0.993	0.627	0.761	I(0)
	$\rho_i = 1$	0.173	0.746	0.377	0.538	
GIP	$\alpha_m = 1$	3.273	0.463	12.39	0.172	I(0)
	$\rho_i = 1$	0.484	0.529	0.365	0.827	
CO_2	$\alpha_m = 1$	81.346	0.000	9.302	0.774	I(1)
	$\rho_i = 1$	6.844	0.000	1.104	0.093	
GHG	$\alpha_m = 1$	14.08	0.999	13.94	0.738	I(0)
	$\rho_i = 1$	-0.743	0.458	1.003	0.303	
FDI	$\alpha_m = 1$	6.45	0.749	11.39	0.328	I(0)
	$\rho_i = 1$	0.27	0.631	0.837	0.394	
TOP	$\alpha_m = 1$	5.451	0.322	8.547	0.552	I(0)
	$\rho_i = 1$	0.464	0.302	1.432	0.103	
POLSTAB	$\alpha_m = 1$	3.263	0.652	9.470	0.733	
	$\rho_i = 1$	0.583	0.339	1.331	0.115	

Source: Author's computations (2025) using Eviews 13.

4.5 Regression Analysis

In this section, the regression analysis used for evaluating the hypotheses of the study are presented and analysed. As noted earlier several empirical tests are conducted in the analysis in order to achieve the objectives of the study.

4.5.1 Results of PMG Estimates

The analysis of the regression results for the estimated models specified in the previous chapter is performed in this section. The PMG regression analysis is performed for the panel of 19 SSA countries for the period of 24 years (2000 to 2023). This implies that both the short-run and the long run relationships are determined. The results of the effects of both insurance and emissions variables on economic growth are presented in Table 4.6. The upper panel of the result shows the long run effects of the explanatory variables. In the long run results, the coefficient of insurance penetration rate (IPR) is significant at the 1 percent level in both the recursive and complete model results. The coefficient is positive and shows that insurance penetration significantly promotes economic growth in SSA. Given that penetration involves sectoral share, especially in the financial sector, the result shows that insurance penetration actually enhances financial deepening by improving risk management and stabilising investment efficiency. The greater the share of the insurance sector in total economic activities, the higher the performance of economies in SSA. From the result, a 1 percent increase in insurance penetration is associated with a 4.692 percent rise in economic growth in the insurance-only model, and a 2.135 percent increase in the full model.

The coefficient of insurance density (IND) in the long run result is also significant at the 1 percent level and is also positive. This shows that increases in insurance density (or per capita insurance expenditure) tends to lead to improvement in economic performance for SSA countries. Based on the long run coefficients, the result shows that a 1 percent rise in per capita insurance expenditure leads to around 0.45–0.58 percent increase in economic growth in SSA. Thus, the result reveals that the greater the per-person use of insurance services, the better the contribution to economic growth. The coefficient of gross Insurance premium (GIP) is significant in positive when carbon emissions are ignored but negative when emissions are included. This shows that when ignoring environmental costs, higher premiums appear to be growth-enhancing. However, when carbon and environmental factors are considered, insurance premiums might lead to worsening economic performance which may arise from increased systemic risks due to climate exposure leading to negative effects. Moreover, the result suggests that environmental risks embedded in insurance portfolios may undermine economic growth prospects in SSA in the long run.

Table 4.6: PMG Results for Insurance, Carbon Emissions and Economic Growth

Variable	*Only insurance*		*Only Carbon emission*		*Full model*	
	Coeff.	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
Long-run (Pooled) Coefficients						
IPR	4.692	0.00			2.135	0.00
IND	0.454	0.00			0.584	0.00
GIP	0.090	0.00			-0.165	0.01
CO_2			-0.658	0.00	-2.856	0.00
GHGN			3.339	0.00	1.896	0.04
FDI	0.095	0.00	0.067	0.00	0.059	0.00
TOP	-0.019	0.00	-0.018	0.00	-0.010	0.00
POLSTAB	0.183	0.00	0.705	0.00	-0.053	0.58
Constant	11.258	0.00	11.654	0.00	10.450	0.00
Short-run (Mean-Group) Coefficients						
ECM_{t-1}	-0.005	0.70	-0.006	0.38	-0.005	0.21
ΔIPR	-0.179	0.03			-0.018	0.25
$ΔIPR_{t-1}$	-0.078	0.34				
ΔIND	0.097	0.00			0.009	0.19
$ΔIND_{t-1}$	0.062	0.02				
ΔGIP)	-0.009	0.68				
$ΔGIP_{t-1}$	-0.010	0.63				
$ΔCO_2$			2.479	0.00	2.291	0.00
ΔGHG			-2.735	0.00	-2.535	0.00
ΔFDI	0.005	0.13			0.000	0.74
$ΔFDI_{t-1}$	0.005	0.09				
ΔTOP	0.000	0.92				
ΔPOLSTAB	0.004	0.85			0.005	0.17
$ΔPOLSTAB_{t-1}$	0.001	0.95				

Source: Author’s computations (2025) using Eviews 13.

The second panel of the estimation shows the recursive estimates for carbon emission variables. The results are similar to those of the full model estimate. The two variables exhibit a mixed effects on economic growth in the long run. The coefficient of carbon emissions is significant and negative, while that of greenhouse gas is positive and also significant at the 5 percent level.

Thus, while carbon emissions per capita significantly reduce long-run economic growth in SSA countries, greenhouse gas emissions initially correlate positively with growth. This result tends to suggest that over time greenhouse gas emissions reflect the traditional industrialisation-growth nexus in SSA as also indicated by other advanced economies. The result essentially shows that carbon emission hurt economic growth in the long run. The coefficient of FDI is significant and positive in the results, indicating that foreign direct investment promotes long run economic growth in SSA. Trade openness however has a significant negative coefficient in the long run estimates. This indicates that excessive external economic integration among SSA countries is likely to hurt economic growth over time. The coefficient of political stability is significant in both recursive estimates but insignificant in the full result. This show that improvement in the institutional quality of political stability tends to promote long run growth in SSA.

The coefficient of the error correction term (ECM_{t-1}) is negative (as expected) but only slightly significant. The coefficient is quite small at between –0.005 and –0.006. It shows that there is weak short-run adjustment toward long-run equilibrium in the model. Thus, insurance and environmental factors are shown to play a very little role in leading the economies in SSA to long run equilibrium. The result shows that any disequilibrium in the economy is likely to persist longer in SSA.

The short run results are reported in the lower panel of Table 4.6. The short-run dynamics show limited responsiveness. This is easily demonstrated by the weak error correction mechanism in the results. In the short run result, the coefficient of current IPR is significant, but negative while that of lagged IPR is insignificant. This shows that in the short run, expanding insurance penetration may initially disrupt economic growth by distorting savings patterns, raising costs, or straining financial systems. The long run estimates however show that there are long-run benefits.

The coefficient of current and lagged IND is significant at the 5 percent level and also positive. This shows that increases in per capita insurance use immediately boosts economic growth by increasing demand and financial sector growth. The coefficient of GIP fails the significance test and indicates that insurance premium does not have short run effects on economic growth in SSA. The coefficient of CO_2 shows a positive short-run impact while that of GHG shows a negative short-run impact. These coefficients are reverse with the long run estimates. This shows that while CO_2 improves and greenhouse gases limit growth in the short run, the long run effects are reversed. FDI, TOP and POLSTAB are mostly statistically insignificant short-run effects.

The results of the PMG estimates of the interactive effects of insurance development and carbon emission in economic growth are reported in Table 4.7. Again, the focus is on the long run estimates since they are the more stable outcomes. In the result, only IPR exhibits clear positive effects on economic growth in the models with interaction terms. This affirms the importance of financial deepening in fostering resilience and promoting sustainable economic activities. The main aim is to examine the coefficients of the interaction terms in this result. The coefficient of the interaction between insurance penetration and carbon footprint (IPR×CFP) is significant and positive in the long run estimates. This shows that deeper insurance markets mitigate the adverse impacts of environmental degradation on growth. In essence, insurance penetration enhances the economy's capacity to absorb environmental shocks, thereby softening the growth-environment trade-off. The result suggests that insurance markets buffer the economic risks associated with carbon-intensive activities. Firms and sectors that emit carbon can better sustain activities through risk protection mechanisms (insurance). This tends to moderate the potential economic harm of environmental degradation. Thus, insurance is shown in this study to soften the environmental-growth tradeoff in SSA.

Table 4.7: Results with Interaction Terms

Variable	Interaction term: IPR and carbon footprint			GIP and carbon footprint			IND and carbon footprint		
	Coeff.	**t-Stat.**	**Prob.**	**Coeff.**	**t-Stat.**	**Prob.**	**Coeff.**	**t-Stat.**	**Prob.**
Long-run (Pooled) Coefficients									
IPR	3.868	4.64	0.00	2.653	5.76	0.00	1.888	4.22	0.00
IND	-0.165	-1.26	0.21	-0.088	-0.92	0.36	0.058	1.95	0.05
GIP	-0.242	-2.66	0.01	0.165	2.00	0.05	-0.078	-2.33	0.02
IPR×CFP	1.560	2.98	0.00						
GIP×CFP				-0.082	-0.63	0.53			
IND×CFP							-0.085	-0.87	0.38
FDI	0.211	3.62	0.00	0.078	4.80	0.00	0.168	4.09	0.00
TOP	0.026	2.54	0.01	-0.015	-4.53	0.00	0.014	2.41	0.02
POLSTAB	0.082	0.40	0.69	0.608	6.06	0.00	0.290	1.93	0.05
Constant	14.024	25.19	0.00	13.774	34.68	0.00	12.174	33.94	0.00
Short-run (Mean-Group) Coefficients									
ECM_{t-1}	-0.009	-3.61	0.00	-0.012	-1.47	0.14	-0.009	-1.98	0.05
ΔIPR	-0.236	-5.45	0.00				-0.185	-2.51	0.01
ΔIND	0.091	3.56	0.00	0.052	2.41	0.02	0.014	2.94	0.00
ΔIPR*CFP	0.290	2.10	0.04						
ΔGIP*CFP				-0.046	-1.80	0.07			
ΔIND*CFP							-0.090	-0.72	0.47
ΔFDI							0.004	1.48	0.14
D(TOP)	0.000	0.77	0.44	0.001	1.72	0.09			
Observations	437			437			437		

Source: Author's computations (2025) using Eviews 13.

Conversely, the interaction terms involving insurance density (IND×CFP) and gross insurance premiums (GIP×CFP) are not statistically in the models. This shows that simply having more people insured (without penetration or deeper market development) does not meaningfully influence the environmental impact on growth. Since, insurance penetration indicates market depth, the result indicates that surface indicators of insurance activity (e.g., number of policyholder numbers or the volume of premium) alone do not provide the same protective effect against environmental risks unless accompanied by deeper market integration. The interactions terms in the short run estimates are similar to those of the long run. This implies that only insurance sector depth has the capacity to exert intertemporal mitigating influence on the effects of carbon emission on economic growth in SSA.

The coefficient of the ECM in the result has the expected negative sign and is significant in two models. The coefficient is however very low at -0.009. This shows that adjustment towards long-run equilibrium occurs slowly but steadily. Essentially, any deviations from equilibrium are gradually corrected in the system.

4.5.2 Robustness Test for PMG Results

In order to check for the robustness of the estimates in the study, the multicollinearity and normality tests are conducted, and the results are presented.

A. Multicollinearity Tests

The regressors in the models used contain variables that may effectively measure similar effects. For instance, the three insurance sector development variables and the two environmental degradation variables are measures of the dimension of the insurance markets and climate change respectively among the countries. It is therefore important to specifically test whether the effects of each of these variables are sufficiently measured in the estimations. The test for multicollinearity in the estimates is therefore conducted in this regard. In Table 4.8, the results of the multicollinearity test for the three models for the PMG estimation are presented. The results show the estimates of the centred variance inflation factors (CVIF) variables. The CVIF value must be less than 5.0 for the variable in an equation to be free from collinearity. In the report on Table 4.8, the CVIF values for all the variables are less than 5.0. This shows that the estimated coefficients for the equations do not integrate excessively among themselves and the estimates are therefore reliable. The absence of multicollinearity implies that the coefficient estimates in the regression results are well defined for each of the explanatory variables.

Table 4.8: Post Estimation Test Results – Multicollinearity Test

Variable	EFPC
IPR	1.073
LIND	0.482
GIP	0.377
CO_2PC	0.492
GHGN	0.674
FDI	0.438
TOP	3.167
POLSTAB	3.029

Source: Author's computations (2025) using Eviews 13.

The robustness checks provided for the ARDL-based PMG estimates also involves evaluating the stability of the estimated results over time. This test is performed by considering that normality of the residual distribution. The normality test is conducted using the J-B procedure, and the result (shown in Figure 4.5) indicates that the J-B statistic failed the significance test even at the 5 percent level. Note that the null hypothesis is the absence of non-normality. This implies that the null hypothesis of normality in the residual distribution is accepted for the estimated panel relationships. Thus, the tests indicate that the residuals are normally distributed. With this outcome, each of the estimated equations can be adjudged to be stable and effective for long term prediction and analysis.

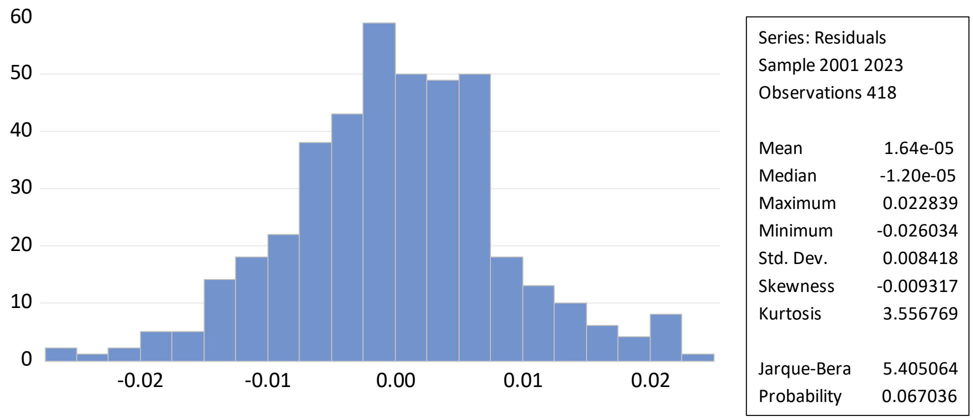


Fig. 4.5: Kuznets Hypothesis for CO_2 Emission and Economic Growth

Source: Author's computations (2025) using Eviews 13.

4.5.3 Analysis of the Kuznets Curve in SSA

The fourth objective of this study is to determine the presence or otherwise of the Kuznets hypothesis or the environmental Kuznets curve (EKC) regarding economic performance and environmental degradation among SSA countries. It should be noted that the Kuznets curve proposes a parabola in terms of the relationship between economic transformation and the quality of the environment, indicating that with lower economic activities the environment is less distressed compared to the next period when economic activities intensify. However, as the economy continues to develop and transform, environmental degradation eventually declines. Thus, it is expected that the levels of economic growth in the environmental equation should be positive while higher orders of the variable should be positive. In Figure 4.6, the result for the Kuznets hypothesis for CO_2 emission and economic growth is presented in a scatterplot. For both short run and long run. It is seen that there is a non-linear relationship with the relationship changing as the six of the economy increases. This suggests that a non-linear estimation of the relationship between carbon emission and economic growth may yield an EKC outcome.

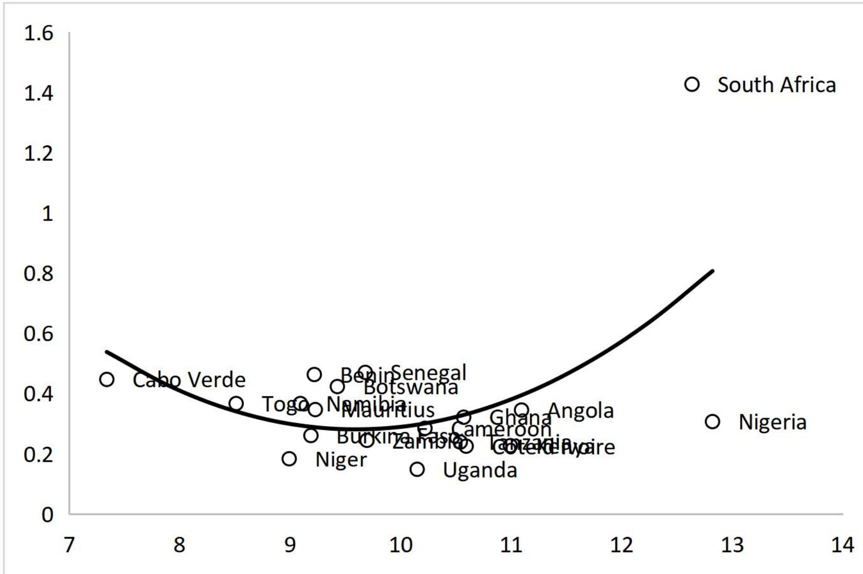


Fig. 4.6: Economic Growth and carbon footprint

The results of the estimations for testing the EKC is presented in Table 4.9. Note that only the long run estimates are reported since these are the stable results for testing the EKC. For the test with CO_2 emissions as measure of degradation, the results show a significant positive impact of economic growth in the linear equation (without square). This shows that economic growth significantly improves CO_2 emission in SSA. The coefficient of the squared economic growth variable is however negative and significant. This shows that at very high levels of economic size, the effect on CO_2 emission becomes negative. The positive coefficient of GDP and the negative coefficient of GDP squared demonstrate an inverted-U relationship consistent with the EKC. This implies that at lower levels of income, economic growth exacerbates carbon emissions. However, beyond a certain income threshold, growth contributes to environmental improvement over time. As noted by the theory, this may be linked to structural change, improved technology, and environmental policy adoption.

Table 4.9: Results for Testing the EKC for SSA Countries

Variable	***Dependent variable = CO_2***				***Dependent variable = GHG***			
	Linear		*Squared*		*Linear*		*Squared*	
	Coeff.	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
LRGDP	0.069	0	0.322	0.05	-0.064	0.00	-0.357	0.03
$LRGDP^2$	--	--	-0.125	0.02	--	--	0.017	0.04
Constant	-0.372	0.01	-1.578	0.06	0.939	0.00	2.252	0.01
ECM_{t-1}	-0.107	0	-0.126	0	-0.131	0.00	-0.182	0.00

Source: Author's computations (2025) using Eviews 13.

Conversely, the results for greenhouse gas (GHG) emissions reveal a U-shaped relationship, with a negative linear GDP term and a positive quadratic term. This indicates that while emissions decline initially with rising GDP, they begin to rise again at higher income levels. This is the reverse of the EKC in SSA when another measure of environmental degradation is considered. This result reveals potential weaknesses in environmental governance or the inability of SSA economies to wean themselves away from greenhouse gas emissions-intensive activities. The statistically significant and negative error correction terms across both models suggest the presence of long-run cointegrating relationships and relatively strong short-run adjustments toward equilibrium.

4.5.4 Casualty Tests

The last objective of the study focuses on examining causality among the major variables of the study, especially among economic, environmental and insurance factors. Hence, the panel causality test is analysed as reported in Table 4.9. Since the data is panel in nature, the pairwise Dumitrescu Hurlin panel causality test is conducted. For the panel analysis, evaluation of the causality is performed based on both the W- and the Zbar-tests which provide critical information on the null hypotheses of one variable not causing another variable. This implies that the rejection of each of the null hypothesis (based on the significance of the W-statistic or the Zbar statistic for the particular relationship) shows that causality actually exists – i.e., runs from one variable to the other. Note that the causality test is conducted only for the critical variables in the analysis.

Table 4.10: Results of Dumitrescu Hurlin panel causality test Table Causality Tests

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
IPR does not homogeneously cause LRGDP	2.846	0.975	0.330
LRGDP does not homogeneously cause IPR	4.665	4.033	0.000
IND does not homogeneously cause LRGDP	3.056	1.328	0.184
LRGDP does not homogeneously cause IND	4.808	4.273	0.000
GIP does not homogeneously cause LRGDP	2.023	-0.410	0.682
LRGDP does not homogeneously cause GIP	5.151	4.851	0.000
CO_2PC does not homogeneously cause LRGDP	2.133	-0.224	0.823
LRGDP does not homogeneously cause CO_2PC	4.682	4.062	0.000
GHGN does not homogeneously cause LRGDP	2.276	0.016	0.987
LRGDP does not homogeneously cause GHGN	3.452	1.993	0.046
CO_2PC does not homogeneously cause IPR	3.425	1.949	0.051
IPR does not homogeneously cause CO_2PC	2.768	0.843	0.399
GHGN does not homogeneously cause IPR	2.604	0.568	0.570
IPR does not homogeneously cause GHGN	3.511	2.092	0.036
CO_2PC does not homogeneously cause IND	3.688	2.391	0.017
IND does not homogeneously cause CO_2PC	4.053	3.003	0.003
GHGN does not homogeneously cause IND	2.823	0.935	0.350
IND does not homogeneously cause GHGN	3.213	1.592	0.111
CO_2PC does not homogeneously cause GIP	5.093	4.754	0.000
GIP does not homogeneously cause CO_2PC	4.180	3.217	0.001
GHGN does not homogeneously cause GIP	6.746	7.533	0.000
GIP does not homogeneously cause GHGN	3.553	2.164	0.031

Source: Author’s computations (2025) using Eviews 13.

In the causality result, the W-statistic for causality running from LRGDP to IPR is significant at the 1 percent level, but the W-stat for causality running from IPR to RGDP is not significant at the 5 percent level. This shows that while real GDP causes changes in IPR, IPR does not, in turn, influence movements in real GDP. Thus, causality is unidirectional between real GDP and IPR in

SSA. A similar result is obtained for causality between RGDP and IND as well as between RGDP and GIP. With causality only running from the insurance factors to real GDP and not the other way around. Thus, the Table shows that there is unidirectional causality from economic growth to insurance development, but no evidence that insurance variables Granger-cause economic growth. This implies that in SSA, insurance markets are growth-followers, not growth-drivers, at least in the short-to-medium term.

We also examine causality between the environmental variables and real GDP. The W-statistic for the null hypothesis of CO_2PC not homogeneously causing LRGDP is not significant, although the causality running from LRGDP to CO_2 is significant at the 1 percent level. In the same vein, the W-stat for the null hypothesis that GHGN does not homogeneously cause LRGDP fails the significance test at the 5 percent level, while the coefficient of causality running from GHGN to RGDP is significant at the 5 percent level. These results reveal that causality flows from growth to pollution, not the other way. This means that SSA countries seem to follow a typical development path where economic activity increases environmental pressure, validating the first stage of the Environmental Kuznets Curve.

In terms of causality between insurance and environmental factors, it is seen that there is a significant bidirectional causality between insurance premiums (GIP) and both emissions variables ($CO_2$and GHG). As pollution rises, demand for insurance likely increases (e.g., disaster coverage), and greater insurance activity may stimulate risk-intensive sectors. For insurance penetration (IPR), causality to GHG is weak but significant, suggesting that as insurance grows, and industrial or carbon-intensive activities may increase.

The panel causality test results reveal a strong unidirectional causal relationship from economic growth (RGDP) to all key insurance variables (IPR, IND, GIP). This indicates that insurance market development in Sub-Saharan Africa is driven by economic performance rather than acting as a driver of growth. Similarly, a significant causality exists from GDP to carbon emissions (CO_2) and greenhouse gas (GHG) levels, with no evidence of reverse causality. This shows that growth exacerbates environmental degradation in the region. Interestingly, the insurance-emission nexus presents a more complex picture. While no causality is observed between insurance penetration and CO_2, gross insurance premiums (GIP) display strong bidirectional causality with both CO_2 and GHG emissions. This suggests a feedback loop where increased environmental risks raise demand for insurance and the expansion of insurance activity may indirectly stimulate more pollution-intensive sectors.

Table 4.11: Test Results

Causality factors	Causal Link	Null hypothesis
IPR and GDP	GDP ➔ IPR (significant)	Partial rejection
	IPR ⇏ GDP (not significant)	
IND and GDP	GDP ➔ IND (significant)	Partial rejection
	IND ⇏ GDP (not significant)	
GIP and Insurance	GDP ➔ GIP(significant)	Partial rejection
	GIP ⇏ GDP (not significant)	

Source: Author's computations (2025) using Eviews 13.

4.6 Hypotheses Testing

The test of this hypothesis is conducted for the long-run coefficients in the models. These are the stable estimates that are more reliable for policy implications.

Hypothesis One

Insurance penetration has no significant effect on economic growth in selected Sub-Saharan African countries

The test of this hypothesis is based on the coefficient of IPR in the results in Table 4.6. In the result, the coefficient of IPR is 4.692 (p-value < 0.01) in the recursive estimates. The null hypothesis is therefore rejected, indicating that insurance penetration has a significant positive effect on economic growth in selected Sub-Saharan African countries.

Hypothesis Two

Insurance density has no significant effect on economic growth in selected Sub-Saharan African countries

The second hypothesis is tested based on the results of the coefficient of IND in the long run result in Table 4.6. In the result, the coefficient of IND is 0.454 (p-value < 0.01) in the recursive estimates. The null hypothesis is therefore rejected, indicating that insurance density has a significant and positive effect on economic growth in selected Sub-Saharan African countries.

Hypothesis Three

Gross premium has no significant effect on economic growth in selected Sub-Saharan African countries

The third hypothesis is tested based on the results of the coefficient of GIP in the long run result in Table 4.6. In the result, the coefficient of GIP is 0.090 (p-value < 0.01) in the recursive estimates and -0.165 (p-value < 0.01) in the full result. Considering that the complete model shows the effects on economic growth with all relevant factors taken into cognizance, the result from GIP estimates reflect that the null hypothesis is therefore rejected. This indicates that gross premium payment has a significant negative effect on economic growth in selected Sub-Saharan African countries.

Hypothesis Four

The Environmental Kuznets Curve hypothesis (EKC) does not exist in the selected Sub-Saharan African countries

The test of this hypothesis is based on the non-linear estimates reported in table 4.8. The EKC is proven when the coefficient of RGDP is positive and significant while that of the square is expected to be negative and significant. In the result with CO_2, the coefficient of GDP is positive at 0.322 (p-value < 0.05) and that of RGDP squared is negative at -0.125 (p-value < 0.05). Both coefficients pass the significance test at the 5 percent level. Thus, the null hypothesis is rejected in this case which shows that the environmental Kuznets curve hypothesis (EKC) actually exists in the selected Sub-Saharan African countries.

Hypothesis Five

Insurance sector development does not significantly influence the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries

The test of this hypothesis is based on the coefficients of the interaction terms in the long run results reported in Table 4.7. In the result the coefficient of IPR is 1.56 (p-value < 0.01), while that of IND is -0.082 (p-value > 0.05) and that of GIP is -0.085 (p-value > 0.05). This shows that only the coefficient of the interaction with IPR is significant at the 1 percent level. Given that one of the coefficients is significant. The null hypothesis can be rejected. This shows that insurance sector development significantly influences the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries.

Hypothesis Six

Insurance sector development does not Granger-cause economic growth; economic growth does not Ganger-Cause insurance sector development in the selected Sub-Saharan African countries or Carbon footprint does not Granger-cause economic growth; economic growth does not Granger-cause carbon footprint in the selected Sub-Saharan African countries.

The result of the test for the test for the last hypothesis is reported in Table 4.11 below. It is seen that the Z-bar statistics for the null hypothesis for GDP not granger causing each of the insurance variables is rejected, while the reverse is not rejected. This shows that while insurance sector development does not Granger-cause economic growth, economic growth Ganger-Causes insurance sector development in the selected Sub-Saharan African countries.

4.7 Discussion of Findings

The main findings in this study reveal important areas for evaluation of policy implications and discussion of the results. First, the study found that insurance penetration significantly boosts economic growth in Sub-Saharan Africa (SSA) both directly and indirectly. This finding aligns with empirical evidence highlighting the insurance sector's role as a catalyst for financial intermediation, risk mitigation, and capital formation in an economy (Ul Din et al., 2017; Ouedraogo et al., 2018; Aigbovo & Iroh, 2021; Aigbovo & Orobator, 2023; Dawd & Benlagha, 2023). These studies confirm that a greater share of the insurance sector in total output significantly improves the chances for greater growth prospects, especially in SSA countries. The positive effect of insurance penetration on economic growth can be explained by noting that insurance is the major instrument for mitigating against both household and business risks. In particular, insurance reduces uncertainty for businesses and households by pooling risks Ul Din et al., 2017; Etale, 2019). This encourages entrepreneurship and greater investment in high-risk sectors and innovation which may not attract such participation without insurance cover. This then helps to drive up productivity and improve job creation in the economy.

Moreover, insurance penetration directly influences the dimension of financial intermediation and capital mobilisation in the economy. As also noted by Akinlo and Apanisile (2014), resources pooled by insurance firms are more efficiently channeled into long-term investments that critically bridge the savings-investment gap in SSA. Thus, the result implies that policies that promote the share of the insurance sector in GDP will directly improve economic growth and stability over time. These policies would involve expansion of the insurance market, including the application of microinsurance that can help to develop affordable products tailored to informal sectors in SSA countries.

The study also found that insurance density has a significant positive effect on economic growth in Sub-Saharan African countries. This finding is consistent with a growing body of empirical research that demonstrate the critical role of the insurance sector in fostering economic development in the region. For instance, Horvey et al. (2024) found the spread of insurance into led-reached population easily helps to mitigate both financial and non-financials risks to both income and businesses. It should be noted that insurance density (which measures per capita insurance spending) reflects the depth and accessibility of insurance services to individuals and businesses. Thus, the result from this study implies that the greater financial protection and risk management capacity that insurance offers to a larger proportion of the population tends to stimulate investment as well as promote enterprise development and economic stability over time (Horvey et al., 2024).

Furthermore, empirical evidence from SSA countries supports also the conclusion of the study regarding insurance density. For instance, increased insurance density in Nigeria and Ghana has been linked to higher economic growth rates (PwC, 2020; Aigbovo & Iroh, 2021; Makwe et al., 2021). Although some contexts within the empirical literature show mixed results (e.g., Nkoro et al., 2019; Oloyede et al., 2023), the overall consensus is that expanding insurance coverage is a viable pathway to stimulate sustainable economic growth in SSA.

The role of gross premium on economic growth in SSA was also found to be positive and direct, although the indirect effect (through negative climate effect mitigation) was not established. This result aligns with previous studies like Nazar et al. (2019) and Din et al. (2024). These studies have shown that insurance facilitates economic growth by mobilising long-term savings through premium collection. In this case, insurance firms channel increased premium into productive investments such as infrastructure, industry, and services (Din et al., 2024). This financial intermediation function helps bridge the savings-investment gap prevalent in many SSA economies. Moreover, insurance reduces uncertainty for businesses and households by providing coverage against risks such as natural disasters, health shocks, and property loss, thereby encouraging risk-taking and innovation essential for growth (Mirela et al., 2022; Horvey et al., 2024). Although studies like Obayagbona, and Iroh (2023) showed results contrary to those of this study, evidence from the empirical analysis suggests that insurance premium can directly improve investment in the economy.

In this study, the Environmental Kuznets Curve (EKC) hypothesis was validated for SSA countries, although the effects were found to depend on the measurement of environmental effects. This result supports findings by Aduebe (2013), Kwakwa and Alhassan (2018), Egbetokun, et al., (2019), and Vanghan and Vanghan (2014) for individual SSA countries. In the same vein, studies by Acheampong et. al., (2019), Yusuf et. al., (2020), Mahmood et al. (2020) and Bibi and Jamil (2021) have also established the existence of the EKC for the entire SSA region. This validation implies that the relationship between economic growth and environmental degradation (measured by carbon emissions in this study) in SSA follows an inverted U-shaped pattern, consistent with the EKC theory. Essentially, the result implies that at lower levels of economic development, increases in GDP are associated with rising carbon emissions. This stage reflects the initial phase of industrialization and economic expansion, where growth relies heavily on fossil fuel consumption as well as energy-intensive industries. Moreover, environmental regulation is limited in this case. As income however continues to grow beyond a certain threshold (captured by the positive coefficient on GDP and negative coefficient on GDP squared), the trend reverses. Further economic growth leads to reductions in carbon emissions. This turning point suggests that higher income levels enable investments in cleaner technologies as well as better environmental policies and overall shift toward less polluting service-based economies.

The finding of differences in the EKC outcome with application of different environmental degradation variables portends significant implications. From the result of the study, the validation of EKC appears highly sensitive to the specific environmental indicator used in SSA. This study appears to align with previous studies that have observed significant attenuating influences of environmental indicator and the timeframe studied in terms of testing the EKC. In particular, Madaleno and Moutinho (2021) confirm that the EKC test “results are sensitive to models and measures adopted”, while Mahmood, Alkhateeb and Furqan (2020) proved the EKC theory for methane gas emissions only in SSA. Moreover, Kwakwa et. al., (2018) found that the existence of the EKC hypothesis or otherwise within the context of the financial sector and natural resources extraction is found to be dependent on the source of CO_2 emissions in Tunisia. The mixed findings for EKC in SSA also suggest that SSA countries do not particularly follow a uniform environmental trajectory as they develop economically. Instead, they exhibit complex pathways that differ by country, pollutant sources and sector of dominance (Ogundari et al., 2017; Jeetoo & Chinyanga, 2023). Awad and Warsame (2017) and Bibi and Jamil (2021) however refuted the EKC for SSA countries. As noted earlier, the type of pollutants being considered as well as the period of the study may have influenced their results.

The study also presented evidence that insurance development (especially specifically insurance penetration) significantly moderates the relationship between carbon emissions and economic growth in Sub-Saharan Africa (SSA). It was shown that insurance penetration dampened the negative effects of carbon emissions on economic growth in the region. Findings by Nazar et al. (2019) and Dawd and Benlagha (2023) appear to be in line with our finding. Given that insurance penetration reflects the extent to which insurance services are available and utilised within an economy, this result reveals that penetration increases the financial protection against environmental risks which tend to directly reduces economic uncertainty and vulnerability. This risk mitigation enables businesses and households to invest and operate with greater confidence in the economy. Consequently, insurance helps cushion the adverse economic impacts of environmental degradation in the SSA region and also support more stable and sustained economic growth over time (Horvey et al., 2024). Similarly, insurance companies often serve as long-term institutional investors. For SSA economies, it appears that more of these companies are channeling premiums into infrastructure and green technologies that can reduce carbon intensity in the region. Thus, a more developed insurance sector promotes investments in renewable energy, energy efficiency and climate-resilient infrastructure which, in turn contribute decoupling the process of economic growth from carbon emissions.

Finally, the result from the study showed that causality only runs from economic growth to insurance development irrespective of the measure of insurance development used. This suggests that it is economic growth momentum that leads to expansion and deepening of the insurance markets in SSA. Moreover, there is evidence that if regulatory incentives that channel growing incomes into formal risk protection products in the region, the insurance market will develop further. (e.g., agricultural, health, disaster insurance). The finding that insurance is growth-following in SSA confirms previous findings by Sibindi and Godi (2014) and Ukpong and Acha (2017) who also found unidirectional relationship exists between GDP and total life insurance premiums.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

In this study the relative effects of insurance sector development and carbon emissions on economic growth in Sub-Saharan African (SSA) countries was examined. In particular, the study considered the roles of different insurance sector factors (including penetration, density and premium size), while also examining the impacts of different forms of emissions on economic growth. The nature of the study ensured that the environmental Kuznets curve (EKC) formulation is tested for SSA countries, while the direction of causality among the environmental, economic and insurance variables were also evaluated. In the study, carbon emission is measured by the tons of CO_2 emissions and augmented by greenhouse gas emissions. Insurance sector development is measured using three variables – insurance penetration rate, insurance density, and gross premium payment rate. Moreover, data used included nineteen (19) selected sub-Saharan African countries over the period of 2000 to 2023. The Pooled Mean Group (PMG) estimation technique was used in the empirical analysis to estimate the long-run and short-run relationship amongst the variables for the panel analysis. Specifically, the following findings were made:

1. That insurance penetration has a significant positive effect on economic growth in the selected Sub-Saharan African countries. This indicated that the share of the insurance sector in SSA economies matters for the growth of the economies.

2. That insurance density has a significant positive effect on economic growth in the selected Sub-Saharan African countries. This implies that insurance per capita drives long run economic growth in SSA.
3. That gross premium payment has a divergent impact on economic growth in selected Sub-Saharan African countries. The complete effect was shown to be negative in the long run.
4. That the Environmental Kuznets Curve hypothesis (EKC) exists for the selected Sub-Saharan African countries. The EKC is however amenable to the type of emissions considered. Why the EKC holds when carbon emissions are considered, it breaks down when greenhouse gas is considered.
5. That insurance sector development (insurance penetration in particular) significantly moderates the relationship between carbon footprint and economic growth in selected Sub-Saharan African countries. Higher insurance penetration significantly lessens the negative effect of carbon emission on economic growth in the region.
6. That while economic growth granger causes insurance sector development, the reverse is not the case. This result holds for both carbon footprint and greenhouse emissions.

5.2 Conclusion

The interplay between insurance sector development, carbon footprint, and economic growth is increasingly significant in Sub-Saharan African (SSA). As the region experiences rapid economic and demographic expansion, the insurance sector is emerging as both a facilitator of growth and a key player in climate resilience. How this interplay manifests in the financial markets in the region is an important consideration for empirical analysis. In this study, the effects of insurance sector development and carbon emissions on economic growth in SSA was examined. The focus was on the evolution of the insurance sector as a critical player in the climate change system in the region.

Indeed, the SSA region faces rising climate risks, including more frequent and severe weather events, which threaten sustainable development. The insurance industry is both directly affected by these risks and has direct consequence for the risks. This indicates that insurance companies will have to increasingly integrate Environmental, Social, and Governance (ESG) principles and become more efficient in offering products that cover environmental risks over time. Thus, the insurance sector plays a dual role in climate mitigation and adaptation. It helps on de-risking investments in renewable energy and climate-resilient infrastructure as well as helping direct significant pools of long-term capital into green investments. Finally, the study has demonstrated that a robust insurance sector is essential for SSA's economic development and climate resilience. This implies that the sector can be positioned to help reduce the region's carbon footprint and drive sustainable growth in the face of mounting environmental challenges.

5.3 Recommendations

Based on the empirical findings regarding the impact of the insurance sector and carbon emissions on economic growth in Sub-Saharan African (SSA), several key policy recommendations emerge.

First, the finding has shown clear positive effects of insurance penetration on economic growth, irrespective of the level of environmental degradation. Thus, there is need to strengthen and deepen the insurance sector in SSA. The nature of the economic activities in SSA countries, which is highly informal however entails that deepening the insurance market will require the promotion of microinsurance and targeted climate risk insurance policies. Essentially, affordable and tailored insurance products that target the most vulnerable populations can be developed. This will directly grow the insurance market and also ensure sustainability in the long run. In this direction, digital platforms can be leveraged on by using mobile technology and other fintech solutions to increase insurance accessibility across SSA economies.

The result also showed that insurance density has a significant positive effect on economic growth in SSA. Thus, policymakers need to prioritise the expansion of insurance take-up at all levels of the economy. In particular, public awareness campaigns to improve insurance literacy and encourage voluntary participation in formal insurance markets needs to be enhanced in SSA countries.

The negative impact of carbon emissions on economic growth in SSA also highlights the urgent need for green economic policies in the region that will directly mitigate or adapt the economy to new realities. This can be achieved by implementing and enforcing environmental regulations to limit carbon emissions from industrial and energy sectors. In the same vein, investments in renewable energy and low-carbon technologies is a critical means for adaption in SSA. As the study has shown, this technology application can be further encouraged by the insurance and overall financial market development.

Moreover, there is need to mainstream environmental risk assessment in infrastructure and urban planning projects to mitigate long-term economic damages from climate change. This way, wastage of economic resources on post-climate crises responses will be limited over time.

Given the finding that insurance development (especially insurance penetration) moderates and dampens the negative effects of carbon emissions on economic growth in Sub-Saharan African.

There is need to focus on the climate mitigating influence of insurance in SSA economies. The result suggests that green and sustainable investments can be promoted in SSA countries through insurance. Thus, there is need to incentivise green insurance products in these countries by encouraging insurers to develop products that support renewable energy, energy efficiency, and climate-resilient infrastructure projects. Also, insurance funds for ESG investments among firms in SSA needs to be developed and expanded. This will facilitate the channeling of insurance premium funds into environmentally sustainable projects aligned with SSA's climate goals.

In order to further ensure deepening of the insurance sector, there is need to strengthen institutional and regulatory frameworks in the sector. Clear and transparent regulations need to be established to ensure policyholders protection, enhance solvency of insurers and foster market confidence over time.

Furthermore, the results from the mitigating role of insurance in the climate-economic growth nexus also implies the need to integrate insurance into national climate and economic policies. This can be achieved by embedding insurance in climate adaptation plans among SSA countries. Thus, insurance can be utilized as a key tool in national climate strategies to enhance resilience and economic stability.

Finally, it was revealed from the study that the EKC exists in SSA countries. Thus, policymakers need to understand that economic growth initially leads to higher emissions due to industrialization and increased energy consumption, especially from fossil fuels. This awareness encourages the design of policies that mitigate environmental harm during early growth phases rather than relying solely on growth to solve environmental problems later.

5.4 Contributions to Knowledge

This study made contribution to knowledge in the following ways:

1. By focusing on different aspects of insurance sector development, the study offered a distributional evaluation of the insurance sector as a net contributor mitigation and adaptation component to environmental degradation and climate change in SSA. This further extends the literature on the relative macroeconomic factors that influence climate change in the region.
2. The study extended knowledge on the Environmental Kuznets Curve (EKC) by applying (i) a time-varying framework using the PMG for SSA countries, (ii) by examining the roles of different emissions components in the EKC formulation. This has led to more varied understanding of the different dimensions and extensions of the knowledge about the EKC phenomenon among SSA countries that are seeking to expand their economies.
3. The study also provided further evidence on the characteristics of growth/economic structure and the environment among SSA countries by highlighting (i) causality between growth and the environment, (ii) causality between insurance sector and economic development, and (iii) possible interactions between the insurance sector and climate change in the drive for attaining sustainable development among SSA countries.

5.5 Areas of Further Study

This study has considered different aspects of the relationship between insurance sector development, carbon emissions and economic growth in SSA countries. There are areas that have not been fully touched which constitute areas for further research.

1. First, the study has considered insurance sector development in terms of depth (penetration) and usage (premium and density) using macro-level dataset. However, climate change, mitigation and adaption may require more micro-level analysis of households and individual firms in order to determine more distributed outcomes. This is a major limitation of this study which future research may examine.
2. There is also need for further research in the estimation of the environmental Kuznets curve hypothesis to determine the different thresholds and turning points where the relationship between economic expansion and climate degradation changes from positive to negative over time. This is a critical analysis that requires more in-depth evaluation.

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APPENDICES

Appendix I : Table 1 : Dataset

COUNTRY	YEAR	RGDP	IPR	IND	GIP	CO_2PC
Angola	2000	31304.50	0.69	388.68	6.50	1.02
Angola	2001	32621.16	0.64	343.44	3.94	0.97
Angola	2002	37079.07	1.07	941.50	2.18	0.92
Angola	2003	38187.73	1.31	1298.34	1.99	0.97
Angola	2004	42369.29	1.21	1530.45	1.69	0.95
Angola	2005	48737.39	0.98	1881.07	1.15	0.81
Angola	2006	54366.56	0.77	2018.71	0.90	0.82
Angola	2007	61983.32	0.58	1821.06	1.00	0.82
Angola	2008	68906.85	0.37	1520.99	0.79	0.89
Angola	2009	69499.45	0.69	2162.90	1.58	0.94
Angola	2010	72556.30	0.68	2451.87	1.78	0.98
Angola	2011	75075.49	0.52	2406.73	1.52	0.98
Angola	2012	81488.52	0.47	2402.75	1.29	0.98
Angola	2013	85525.96	0.49	2480.48	1.34	1.09
Angola	2014	89650.50	0.41	2061.08	1.45	1.14
Angola	2015	90496.42	0.43	1373.78	1.84	1.18
Angola	2016	88161.57	0.23	423.12	1.33	1.07
Angola	2017	88031.78	0.28	686.51	1.51	0.92
Angola	2018	86872.97	0.23	581.56	1.26	0.84
Angola	2019	86262.88	0.23	513.29	1.29	0.85
Angola	2020	81399.19	0.29	415.72	1.56	0.62
Angola	2021	82375.34	0.30	577.43	1.86	0.73
Angola	2022	84883.45	0.31	916.81	1.82	0.77
Angola	2023	85733.38	0.33	752.56	1.74	0.77
Benin	2000	6219.35	0.33	160.07	1.10	0.21
Benin	2001	6551.04	0.43	213.28	1.15	0.25
Benin	2002	6855.21	0.43	233.47	1.27	0.28
Benin	2003	7091.27	0.43	290.78	1.11	0.30
Benin	2004	7405.39	0.40	303.22	1.19	0.31
Benin	2005	7532.26	0.37	285.78	1.31	0.33
Benin	2006	7829.31	0.37	302.07	1.26	0.44
Benin	2007	8298.00	0.38	342.19	1.44	0.49
Benin	2008	8704.32	0.38	406.68	1.29	0.47
Benin	2009	8906.20	0.37	377.42	1.42	0.49
Benin	2010	9094.48	0.36	346.72	1.54	0.52
Benin	2011	9364.02	0.32	344.28	1.55	0.49
Benin	2012	9814.54	0.28	303.53	1.53	0.45
Benin	2013	10520.35	0.37	430.02	1.52	0.46
Benin	2014	11189.20	0.29	354.94	1.55	0.49
Benin	2015	11388.16	0.31	310.72	1.57	0.51
Benin	2016	11768.49	0.31	315.53	1.64	0.61
Benin	2017	12435.95	0.28	299.42	1.62	0.60

Benin	2018	13268.81	0.29	333.05	1.54	0.67
Benin	2019	14179.81	0.27	306.99	1.69	0.63
Benin	2020	14725.56	0.29	344.12	1.69	0.66
Benin	2021	15779.24	0.32	419.87	1.72	0.48
Benin	2022	16765.95	0.35	441.84	1.76	0.48
Benin	2023	17831.07	0.38	530.37	1.79	0.46
Botswana	2000	8491.99	0.81	2807.00	8.64	2.44
Botswana	2001	8513.26	0.86	2753.79	9.34	2.31
Botswana	2002	9029.98	0.99	3085.22	13.02	2.39
Botswana	2003	9447.70	1.01	4292.71	17.54	2.33
Botswana	2004	9703.34	1.07	5289.48	20.37	2.24
Botswana	2005	10145.48	1.00	5380.29	18.93	2.39
Botswana	2006	10994.04	0.86	4536.37	21.70	2.21
Botswana	2007	11630.87	0.89	4930.63	20.01	2.31
Botswana	2008	12009.12	0.93	5129.94	17.17	2.31
Botswana	2009	10310.52	1.15	5823.52	21.83	2.07
Botswana	2010	11354.17	1.03	6372.45	19.67	1.66
Botswana	2011	12130.63	0.95	6953.25	16.60	1.93
Botswana	2012	12109.90	1.00	6584.88	19.24	1.67
Botswana	2013	13454.44	0.90	6014.73	16.22	2.57
Botswana	2014	14220.64	0.79	5619.59	15.30	3.29
Botswana	2015	13530.75	0.85	5226.62	15.45	3.22
Botswana	2016	14505.56	0.73	4907.47	12.91	3.02
Botswana	2017	15102.37	0.67	4728.61	14.00	3.28
Botswana	2018	15734.88	0.72	5328.75	10.55	3.57
Botswana	2019	16211.99	0.70	5013.78	13.28	3.15
Botswana	2020	14796.88	0.71	4510.27	14.19	2.57
Botswana	2021	16560.77	0.71	5531.13	15.27	2.75
Botswana	2022	17469.29	0.70	5859.24	15.95	2.98
Botswana	2023	17946.87	0.70	5462.96	15.85	2.99
Burkina Faso	2000	5107.83	0.45	111.69	0.61	0.07
Burkina Faso	2001	5445.63	0.40	105.08	0.52	0.08
Burkina Faso	2002	5682.68	0.42	120.26	0.48	0.08
Burkina Faso	2003	6126.07	0.44	158.76	0.58	0.09
Burkina Faso	2004	6400.42	0.43	173.70	0.62	0.08
Burkina Faso	2005	6954.82	0.40	178.29	0.72	0.08
Burkina Faso	2006	7389.71	0.39	175.74	0.77	0.08
Burkina Faso	2007	7693.53	0.40	204.23	1.14	0.11
Burkina Faso	2008	8139.75	0.36	220.60	1.11	0.12
Burkina Faso	2009	8380.85	0.38	231.06	1.12	0.12
Burkina Faso	2010	9088.72	0.40	247.58	1.80	0.12
Burkina Faso	2011	9690.63	0.35	254.41	1.74	0.13
Burkina Faso	2012	10315.93	0.34	250.17	1.65	0.15

Burkina Faso	2013	10913.49	0.36	270.41	1.79	0.17
Burkina Faso	2014	11385.70	0.35	270.11	1.87	0.15
Burkina Faso	2015	11832.16	0.41	260.05	2.18	0.21
Burkina Faso	2016	12537.12	0.43	282.84	2.20	0.20
Burkina Faso	2017	13314.86	0.42	300.95	2.24	0.22
Burkina Faso	2018	14194.24	0.41	320.36	2.45	0.24
Burkina Faso	2019	15030.17	0.45	344.06	2.90	0.26
Burkina Faso	2020	15332.40	0.66	544.85	2.76	0.26
Burkina Faso	2021	16396.85	0.65	581.46	2.99	0.27
Burkina Faso	2022	16642.35	0.64	533.72	3.10	0.27
Burkina Faso	2023	17134.99	0.63	553.78	3.04	0.26
Cabo Verde	2000	923.55	1.20	1428.50	1.42	0.62
Cabo Verde	2001	944.16	1.27	1558.03	1.31	0.70
Cabo Verde	2002	993.74	1.61	2137.23	1.30	0.77
Cabo Verde	2003	1035.24	1.39	2388.08	1.46	0.76
Cabo Verde	2004	1140.80	1.23	2375.92	1.49	0.81
Cabo Verde	2005	1219.66	1.37	2739.59	1.47	1.25
Cabo Verde	2006	1317.04	1.46	3296.45	1.53	1.36
Cabo Verde	2007	1516.84	1.35	4486.85	1.69	1.51
Cabo Verde	2008	1623.61	1.41	5526.41	1.72	1.45
Cabo Verde	2009	1599.20	1.42	5205.86	1.75	1.40
Cabo Verde	2010	1628.56	1.43	5124.24	2.02	1.48
Cabo Verde	2011	1692.48	1.40	5595.77	2.19	1.72
Cabo Verde	2012	1710.82	1.32	4930.04	1.98	1.48
Cabo Verde	2013	1721.64	1.25	4957.45	2.01	1.45
Cabo Verde	2014	1733.63	1.19	4752.98	2.08	1.52
Cabo Verde	2015	1749.86	1.21	4131.96	1.99	1.53
Cabo Verde	2016	1824.76	1.22	4385.85	3.09	1.60
Cabo Verde	2017	1907.81	1.23	4795.45	3.67	1.70
Cabo Verde	2018	1978.54	1.20	5149.24	3.54	1.70
Cabo Verde	2019	2116.00	1.26	5532.66	3.77	1.81
Cabo Verde	2020	1675.76	1.28	4539.19	4.87	1.90
Cabo Verde	2021	1793.63	1.32	5239.81	3.36	1.92
Cabo Verde	2022	2077.80	1.36	5863.32	4.18	2.00
Cabo Verde	2023	2191.57	1.39	6757.67	4.48	1.93
Cameroon	2000	17168.57	0.50	351.72	1.44	0.38
Cameroon	2001	17910.98	0.59	424.44	1.45	0.37
Cameroon	2002	18712.86	0.65	513.66	1.61	0.36
Cameroon	2003	19733.30	0.66	650.22	1.62	0.35
Cameroon	2004	21124.28	0.63	708.77	1.60	0.34
Cameroon	2005	21594.98	0.63	718.63	1.61	0.32
Cameroon	2006	22417.66	0.57	681.48	1.56	0.32
Cameroon	2007	23387.80	0.60	796.00	1.57	0.37

Cameroon	2008	24053.81	0.55	814.87	1.50	0.38
Cameroon	2009	24674.22	0.53	780.75	1.58	0.40
Cameroon	2010	25389.53	0.55	762.32	1.67	0.40
Cameroon	2011	26247.50	0.56	846.72	1.73	0.37
Cameroon	2012	27461.70	0.53	767.95	1.73	0.36
Cameroon	2013	28833.56	0.53	838.15	1.75	0.38
Cameroon	2014	30482.79	0.48	788.00	1.75	0.40
Cameroon	2015	32210.23	0.52	734.11	1.78	0.40
Cameroon	2016	33671.22	0.50	720.60	1.86	0.41
Cameroon	2017	34863.58	0.48	722.21	1.88	0.41
Cameroon	2018	36242.61	0.47	761.68	1.88	0.42
Cameroon	2019	37502.07	0.44	678.14	1.89	0.40
Cameroon	2020	37599.55	0.58	908.87	1.90	0.40
Cameroon	2021	38854.94	0.59	992.74	1.91	0.38
Cameroon	2022	40306.87	0.60	967.75	1.93	0.39
Cameroon	2023	41616.17	0.61	1063.62	1.94	0.38
Cote d'Ivoire	2000	30406.07	0.73	687.15	1.85	0.39
Cote d'Ivoire	2001	29751.12	0.60	558.10	2.00	0.38
Cote d'Ivoire	2002	28938.76	0.63	610.40	1.92	0.40
Cote d'Ivoire	2003	27571.15	0.62	689.19	1.75	0.30
Cote d'Ivoire	2004	28449.30	0.66	789.67	2.15	0.31
Cote d'Ivoire	2005	28732.68	0.67	797.41	2.33	0.32
Cote d'Ivoire	2006	29541.67	0.65	805.80	2.24	0.31
Cote d'Ivoire	2007	29867.05	0.66	903.28	2.60	0.30
Cote d'Ivoire	2008	31295.49	0.67	1056.81	2.51	0.32
Cote d'Ivoire	2009	32423.17	0.62	949.67	2.49	0.29
Cote d'Ivoire	2010	34643.52	0.64	986.56	2.60	0.33
Cote d'Ivoire	2011	32783.01	0.60	951.20	2.89	0.31
Cote d'Ivoire	2012	35281.21	0.59	917.40	2.69	0.38
Cote d'Ivoire	2013	39077.54	0.61	1092.15	2.56	0.41
Cote d'Ivoire	2014	42739.89	0.56	1117.67	2.45	0.43
Cote d'Ivoire	2015	45815.01	0.58	1061.58	2.38	0.45
Cote d'Ivoire	2016	49101.21	0.59	1107.61	2.42	0.44
Cote d'Ivoire	2017	52739.98	0.56	1106.61	2.52	0.46
Cote d'Ivoire	2018	55294.25	0.58	1233.51	2.50	0.45
Cote d'Ivoire	2019	59010.79	0.57	1219.52	2.55	0.47
Cote d'Ivoire	2020	59423.70	0.58	1272.13	2.59	0.45
Cote d'Ivoire	2021	63620.99	0.59	1447.47	2.63	0.49
Cote d'Ivoire	2022	67576.85	0.60	1373.94	2.66	0.49
Cote d'Ivoire	2023	71766.62	0.60	1520.67	2.70	0.46
Ghana	2000	20062.00	0.32	82.05	0.39	0.31
Ghana	2001	20864.48	0.31	81.30	0.34	0.33
Ghana	2002	21803.38	0.33	99.42	0.48	0.37

Ghana	2003	22937.16	0.38	134.99	0.42	0.34
Ghana	2004	24221.64	0.39	157.19	0.48	0.31
Ghana	2005	25650.72	0.41	197.43	0.42	0.32
Ghana	2006	27292.34	0.43	393.77	0.44	0.38
Ghana	2007	28478.69	0.45	469.82	1.33	0.39
Ghana	2008	31084.43	0.46	544.26	1.47	0.36
Ghana	2009	32590.32	0.46	477.36	1.48	0.40
Ghana	2010	35164.86	0.44	553.86	1.54	0.44
Ghana	2011	40104.51	0.42	637.87	1.40	0.46
Ghana	2012	43831.33	0.50	776.84	1.25	0.55
Ghana	2013	47036.51	0.47	1080.61	1.40	0.57
Ghana	2014	48379.99	0.42	828.63	1.47	0.53
Ghana	2015	49406.01	0.47	815.82	1.70	0.55
Ghana	2016	51072.71	0.50	951.84	2.08	0.55
Ghana	2017	55224.35	0.46	932.73	2.25	0.57
Ghana	2018	58648.30	0.43	948.76	2.42	0.62
Ghana	2019	62465.00	0.45	980.59	2.59	0.65
Ghana	2020	62786.04	0.50	1103.26	2.35	0.69
Ghana	2021	65973.35	0.51	1246.81	2.63	0.77
Ghana	2022	68491.89	0.52	1159.13	2.66	0.75
Ghana	2023	70508.82	0.52	1186.59	2.58	0.72
Kenya	2000	36630.91	1.22	504.04	6.95	0.29
Kenya	2001	38015.52	1.20	492.91	6.49	0.26
Kenya	2002	38223.41	1.39	559.41	6.99	0.25
Kenya	2003	39344.31	1.37	608.81	7.70	0.21
Kenya	2004	41352.56	1.32	611.25	7.23	0.23
Kenya	2005	43795.12	1.30	680.87	7.38	0.25
Kenya	2006	46629.75	1.29	904.97	6.70	0.27
Kenya	2007	49824.23	1.20	1005.16	6.81	0.26
Kenya	2008	49939.96	1.19	1093.81	6.22	0.27
Kenya	2009	51591.45	1.14	1197.31	5.61	0.31
Kenya	2010	55748.93	1.30	1418.03	6.41	0.33
Kenya	2011	58603.89	1.31	1438.92	5.98	0.33
Kenya	2012	61281.32	1.30	1668.97	6.63	0.30
Kenya	2013	63608.69	1.32	1807.86	6.98	0.32
Kenya	2014	66801.91	1.33	1975.32	7.22	0.36
Kenya	2015	70120.45	1.25	1857.49	6.91	0.38
Kenya	2016	73074.98	1.14	1778.14	6.86	0.40
Kenya	2017	75879.57	1.03	1718.07	6.59	0.41
Kenya	2018	80165.21	0.96	1763.63	6.51	0.38
Kenya	2019	84264.99	0.89	1737.95	6.64	0.38
Kenya	2020	84035.14	0.82	1582.12	6.63	0.37
Kenya	2021	90413.82	0.98	2025.36	6.66	0.40

Kenya	2022	94807.91	1.14	2414.03	6.68	0.39
Kenya	2023	100075.32	1.31	2549.95	6.61	0.39
Mauritius	2000	6730.79	1.49	5917.49	17.26	2.06
Mauritius	2001	6956.11	1.43	5594.76	17.84	2.16
Mauritius	2002	7068.44	1.55	6328.36	18.72	2.19
Mauritius	2003	7487.28	1.56	7563.99	20.08	2.28
Mauritius	2004	7811.48	1.55	8450.49	20.47	2.28
Mauritius	2005	7950.33	1.61	8619.27	22.02	2.42
Mauritius	2006	8337.16	1.51	8587.51	22.75	2.69
Mauritius	2007	8814.63	1.53	10057.03	24.16	2.75
Mauritius	2008	9289.47	1.39	11186.21	22.87	2.80
Mauritius	2009	9597.42	1.47	10766.15	26.32	2.76
Mauritius	2010	10017.52	1.46	11696.33	28.75	2.94
Mauritius	2011	10425.99	1.50	13758.34	29.00	2.92
Mauritius	2012	10790.50	1.39	12884.97	29.96	2.98
Mauritius	2013	11153.10	1.43	13986.45	26.35	3.06
Mauritius	2014	11579.93	1.41	14625.59	27.03	3.16
Mauritius	2015	12007.29	1.40	13286.46	18.84	3.17
Mauritius	2016	12471.07	1.36	13540.23	19.01	3.23
Mauritius	2017	12962.18	1.41	15241.47	20.09	3.33
Mauritius	2018	13481.54	1.38	16113.79	20.05	3.30
Mauritius	2019	13871.33	1.44	16364.62	21.08	3.33
Mauritius	2020	11853.53	1.45	13089.70	25.33	2.97
Mauritius	2021	12257.00	1.44	13043.56	24.25	3.15
Mauritius	2022	13345.41	1.42	14580.41	24.36	3.21
Mauritius	2023	14274.02	1.41	16368.93	23.93	3.34
Namibia	2000	5607.97	1.83	3947.21	19.99	1.07
Namibia	2001	5674.03	1.86	3565.37	22.98	1.33
Namibia	2002	5945.74	2.03	3601.36	29.17	1.13
Namibia	2003	6197.83	2.17	5578.66	30.56	1.20
Namibia	2004	6958.28	2.20	7495.53	33.48	1.25
Namibia	2005	7134.27	2.17	8014.04	36.44	1.32
Namibia	2006	7638.89	2.07	8320.61	35.36	1.28
Namibia	2007	8049.41	1.54	6735.82	37.13	1.30
Namibia	2008	8262.70	1.68	7065.01	32.06	1.47
Namibia	2009	8287.15	1.96	8446.84	32.49	1.48
Namibia	2010	8787.64	2.09	11334.33	32.99	1.51
Namibia	2011	9235.05	1.98	11541.52	32.88	1.57
Namibia	2012	9702.49	1.91	11321.25	32.43	1.62
Namibia	2013	10247.26	1.98	10578.88	33.97	1.68
Namibia	2014	10871.58	1.87	10047.41	33.35	1.70
Namibia	2015	11335.16	1.77	8429.01	34.47	1.74
Namibia	2016	11338.99	1.62	7102.70	33.81	1.75

Namibia	2017	11222.51	1.56	8005.22	35.07	1.67
Namibia	2018	11341.46	1.51	8029.10	34.90	1.64
Namibia	2019	11246.29	1.61	7641.92	36.90	1.60
Namibia	2020	10335.19	1.23	4785.44	38.42	1.42
Namibia	2021	10707.65	1.53	6744.36	36.47	1.41
Namibia	2022	11280.47	1.82	7927.83	38.49	1.47
Namibia	2023	11749.74	2.12	8826.06	39.27	1.47
Niger	2000	4522.12	0.47	91.42	0.59	0.06
Niger	2001	4850.79	0.43	87.70	0.54	0.06
Niger	2002	5089.38	0.41	93.26	0.66	0.06
Niger	2003	5199.85	0.43	114.18	0.60	0.06
Niger	2004	5218.76	0.43	122.87	0.51	0.06
Niger	2005	5601.40	0.45	143.33	0.56	0.06
Niger	2006	5933.62	0.45	148.50	0.54	0.06
Niger	2007	6120.10	0.48	184.86	0.57	0.06
Niger	2008	6593.27	0.43	204.02	0.56	0.06
Niger	2009	6722.66	0.48	219.89	0.63	0.07
Niger	2010	7299.35	0.47	222.45	0.66	0.09
Niger	2011	7471.45	0.48	246.09	0.68	0.09
Niger	2012	8259.61	0.43	227.18	0.70	0.12
Niger	2013	8698.61	0.47	260.72	0.81	0.11
Niger	2014	9276.39	0.41	231.58	0.83	0.11
Niger	2015	9683.87	0.44	214.91	0.75	0.11
Niger	2016	10239.81	0.41	204.20	0.74	0.10
Niger	2017	10752.35	0.35	181.93	0.69	0.09
Niger	2018	11527.75	0.34	198.94	0.67	0.09
Niger	2019	12212.48	0.39	220.65	0.69	0.10
Niger	2020	12646.10	0.41	238.32	0.64	0.10
Niger	2021	12821.07	0.32	192.50	0.66	0.12
Niger	2022	14346.78	0.22	134.90	0.70	0.11
Niger	2023	14705.44	0.13	81.16	0.71	0.11
Nigeria	2000	179675.45	0.33	178.78	0.62	0.79
Nigeria	2001	190308.08	0.36	201.81	0.85	0.82
Nigeria	2002	219480.70	0.33	237.34	0.71	0.73
Nigeria	2003	235606.37	0.33	249.32	0.93	0.78
Nigeria	2004	257401.28	0.29	278.40	0.89	0.74
Nigeria	2005	273974.10	0.30	366.81	0.83	0.71
Nigeria	2006	290575.36	0.28	455.28	1.07	0.62
Nigeria	2007	309727.56	0.27	490.29	1.30	0.55
Nigeria	2008	330679.00	0.32	695.72	1.46	0.58
Nigeria	2009	357255.42	0.35	629.48	1.32	0.50
Nigeria	2010	385856.06	0.28	624.66	1.05	0.57
Nigeria	2011	406337.01	0.26	626.68	0.97	0.61

Nigeria	2012	423525.32	0.25	662.94	0.98	0.58
Nigeria	2013	451780.11	0.22	643.92	0.98	0.64
Nigeria	2014	480286.16	0.20	630.12	0.93	0.66
Nigeria	2015	493026.68	0.20	506.95	0.96	0.62
Nigeria	2016	485055.09	0.18	372.42	0.99	0.62
Nigeria	2017	488964.08	0.18	331.07	0.98	0.59
Nigeria	2018	498365.67	0.19	391.23	1.03	0.61
Nigeria	2019	509371.73	0.20	447.10	1.05	0.62
Nigeria	2020	500232.31	0.22	441.02	1.06	0.57
Nigeria	2021	518476.72	0.22	450.94	1.08	0.60
Nigeria	2022	535335.93	0.23	489.31	1.10	0.58
Nigeria	2023	550647.68	0.23	373.44	1.11	0.56
Senegal	2000	10450.47	0.63	380.96	1.79	0.40
Senegal	2001	10900.98	0.62	395.40	1.89	0.44
Senegal	2002	10908.47	0.72	483.59	1.88	0.45
Senegal	2003	11518.68	0.73	600.16	1.84	0.42
Senegal	2004	12053.53	0.75	686.93	1.86	0.47
Senegal	2005	12573.06	0.73	713.34	1.81	0.51
Senegal	2006	12866.11	0.70	714.37	1.77	0.49
Senegal	2007	13229.85	0.68	812.69	1.65	0.53
Senegal	2008	13719.77	0.62	863.03	1.74	0.53
Senegal	2009	14097.36	0.66	863.98	2.01	0.53
Senegal	2010	14575.38	0.65	829.00	2.08	0.55
Senegal	2011	14769.83	0.64	876.23	2.07	0.58
Senegal	2012	15361.07	0.61	814.89	3.04	0.55
Senegal	2013	15731.64	0.57	783.57	3.11	0.57
Senegal	2014	16710.78	0.57	792.53	3.02	0.59
Senegal	2015	17774.77	0.63	763.09	2.92	0.63
Senegal	2016	18904.54	0.62	791.27	3.16	0.68
Senegal	2017	20304.89	0.63	858.12	3.37	0.66
Senegal	2018	21565.67	0.62	906.46	3.32	0.67
Senegal	2019	22560.63	0.64	913.08	3.43	0.67
Senegal	2020	22863.42	0.68	998.84	3.33	0.64
Senegal	2021	24359.60	0.69	1101.69	3.54	0.71
Senegal	2022	25291.56	0.70	1087.69	3.58	0.70
Senegal	2023	26450.94	0.70	1195.99	3.58	0.67
South Africa	2000	221691.97	1.64	5282.59	33.76	7.36
South Africa	2001	227677.65	1.57	4473.51	35.58	7.51
South Africa	2002	236102.58	1.64	4414.03	28.52	7.72
South Africa	2003	243065.42	1.74	7078.52	27.55	8.12
South Africa	2004	254135.98	1.83	9555.59	27.76	8.69
South Africa	2005	267546.87	1.91	11168.48	32.69	8.82
South Africa	2006	282539.68	2.67	16199.31	30.47	8.81

South Africa	2007	297685.15	2.62	17273.71	41.48	9.10
South Africa	2008	307184.41	2.52	15587.31	53.59	9.55
South Africa	2009	302459.64	2.58	16467.64	51.77	8.83
South Africa	2010	311653.60	2.48	19766.99	52.58	8.87
South Africa	2011	321528.52	2.47	21334.27	52.13	8.39
South Africa	2012	329233.09	2.52	20314.55	54.92	8.57
South Africa	2013	337416.08	2.49	18259.49	57.79	8.65
South Africa	2014	342186.56	2.47	16945.97	60.04	8.71
South Africa	2015	346709.79	2.56	15636.41	63.25	8.11
South Africa	2016	349013.86	2.56	14451.43	59.97	8.04
South Africa	2017	353055.25	2.56	16954.70	60.39	8.15
South Africa	2018	358551.56	2.23	15407.98	58.66	8.08
South Africa	2019	359483.56	2.91	19038.08	58.43	8.03
South Africa	2020	337307.32	2.97	16589.01	60.14	6.91
South Africa	2021	354021.01	2.99	20446.91	61.36	6.97
South Africa	2022	360788.05	3.00	19590.06	61.94	6.56
South Africa	2023	363308.10	3.02	18177.54	62.03	6.29
Tanzania	2000	18486.48	0.35	135.08	0.73	0.09
Tanzania	2001	19608.76	0.35	133.24	0.75	0.09
Tanzania	2002	20999.65	0.36	142.34	0.73	0.10
Tanzania	2003	22400.91	0.42	171.83	0.73	0.11
Tanzania	2004	24081.83	0.44	192.05	0.73	0.14
Tanzania	2005	25882.27	0.47	220.28	0.78	0.16
Tanzania	2006	27572.95	0.45	205.83	0.79	0.16
Tanzania	2007	29439.24	0.50	264.01	0.78	0.15
Tanzania	2008	31113.28	0.49	324.91	0.87	0.15
Tanzania	2009	32752.67	0.48	322.24	0.83	0.14
Tanzania	2010	34828.05	0.47	338.88	0.80	0.16
Tanzania	2011	37500.11	0.47	355.75	0.77	0.19
Tanzania	2012	39187.67	0.48	402.92	0.72	0.22
Tanzania	2013	41845.22	0.46	434.28	0.71	0.24
Tanzania	2014	44662.43	0.49	483.20	0.75	0.22
Tanzania	2015	47413.92	0.47	431.76	0.77	0.25
Tanzania	2016	50669.89	0.43	398.02	0.77	0.26
Tanzania	2017	54096.33	0.36	343.41	0.73	0.26
Tanzania	2018	57054.36	0.36	353.60	0.73	0.26
Tanzania	2019	60363.51	0.40	417.48	0.75	0.29
Tanzania	2020	61565.93	0.37	404.82	0.82	0.28
Tanzania	2021	64226.43	0.42	470.47	0.87	0.31
Tanzania	2022	67159.01	0.46	542.27	0.90	0.29
Tanzania	2023	70563.66	0.51	602.77	0.93	0.29
Togo	2000	3492.83	0.74	303.59	1.50	0.24
Togo	2001	3521.59	0.67	264.12	1.52	0.21

Togo	2002	3656.35	0.65	290.36	1.64	0.22
Togo	2003	3902.06	0.61	326.33	1.77	0.26
Togo	2004	3863.87	0.71	398.63	1.75	0.24
Togo	2005	3683.57	0.96	530.85	1.93	0.22
Togo	2006	3781.19	0.74	409.52	1.89	0.20
Togo	2007	3736.76	0.81	492.44	1.74	0.20
Togo	2008	3887.56	0.72	515.90	1.58	0.25
Togo	2009	4099.58	0.70	504.60	2.28	0.41
Togo	2010	4339.58	0.79	556.28	2.58	0.38
Togo	2011	4592.29	0.88	686.92	3.03	0.33
Togo	2012	4881.73	0.76	579.28	3.26	0.31
Togo	2013	5166.05	0.68	560.76	3.54	0.26
Togo	2014	5457.07	0.73	623.85	3.87	0.23
Togo	2015	5755.46	0.73	546.11	3.83	0.20
Togo	2016	5998.05	0.69	535.69	3.74	0.27
Togo	2017	6238.46	0.70	558.14	3.92	0.23
Togo	2018	6537.60	0.58	491.87	4.24	0.24
Togo	2019	6859.44	0.69	573.21	4.08	0.23
Togo	2020	6996.09	0.71	608.21	4.11	0.26
Togo	2021	7415.21	0.75	703.13	4.19	0.28
Togo	2022	7842.30	0.78	704.72	4.26	0.28
Togo	2023	8344.82	0.82	808.16	4.49	0.27
Uganda	2000	12220.82	0.27	70.47	0.55	0.06
Uganda	2001	12854.30	0.31	73.86	0.64	0.06
Uganda	2002	13976.83	0.33	79.76	0.62	0.06
Uganda	2003	14881.59	0.35	87.59	0.74	0.07
Uganda	2004	15894.61	0.39	113.85	0.78	0.07
Uganda	2005	16901.15	0.38	126.59	0.86	0.08
Uganda	2006	18723.89	0.32	109.15	0.78	0.09
Uganda	2007	20299.03	0.35	142.34	0.83	0.10
Uganda	2008	22066.82	0.36	169.64	0.82	0.11
Uganda	2009	23567.70	0.34	268.59	0.73	0.12
Uganda	2010	24896.35	0.36	299.47	0.76	0.11
Uganda	2011	27234.53	0.34	285.53	0.81	0.12
Uganda	2012	28279.64	0.37	290.75	0.85	0.12
Uganda	2013	29294.01	0.34	276.28	0.93	0.12
Uganda	2014	30789.85	0.33	298.67	1.01	0.13
Uganda	2015	32387.18	0.45	387.89	1.20	0.14
Uganda	2016	33935.62	0.33	250.80	1.16	0.15
Uganda	2017	34998.28	0.33	250.88	1.24	0.15
Uganda	2018	37204.54	0.34	265.99	1.21	0.16
Uganda	2019	39600.05	0.34	275.44	1.23	0.16
Uganda	2020	40768.77	0.38	321.59	1.36	0.15

Uganda	2021	42210.59	0.39	346.79	1.49	0.17
Uganda	2022	44147.22	0.41	390.47	1.47	0.15
Uganda	2023	46503.34	0.42	419.01	1.54	0.15
Zambia	2000	8059.03	0.85	304.66	1.18	0.19
Zambia	2001	8487.52	0.96	380.53	1.38	0.19
Zambia	2002	8869.97	0.83	325.98	1.23	0.19
Zambia	2003	9485.98	0.88	391.40	1.38	0.20
Zambia	2004	10153.08	0.81	444.07	1.24	0.20
Zambia	2005	10887.71	0.70	500.22	1.12	0.21
Zambia	2006	11748.24	0.67	704.97	1.16	0.20
Zambia	2007	12729.51	0.71	793.39	1.25	0.18
Zambia	2008	13719.09	0.82	1128.37	1.36	0.18
Zambia	2009	14984.03	0.81	925.25	1.15	0.20
Zambia	2010	16527.12	0.81	1172.25	1.09	0.21
Zambia	2011	17447.56	0.67	1093.44	1.15	0.23
Zambia	2012	18773.12	0.70	1198.69	1.22	0.29
Zambia	2013	19722.58	0.61	1101.62	1.18	0.30
Zambia	2014	20648.21	0.66	1133.71	1.22	0.32
Zambia	2015	21251.22	0.69	893.11	1.10	0.32
Zambia	2016	22049.22	0.68	841.02	1.30	0.34
Zambia	2017	22826.65	0.73	1089.56	1.33	0.41
Zambia	2018	23747.59	0.69	1014.82	1.27	0.45
Zambia	2019	24089.86	0.76	960.47	1.31	0.38
Zambia	2020	23418.95	0.78	745.85	1.47	0.39
Zambia	2021	24879.10	0.81	915.97	1.49	0.40
Zambia	2022	26175.60	0.84	1217.79	1.50	0.39
Zambia	2023	27580.70	0.87	1158.28	1.55	0.39

Source: World Bank's Development Indicators and the Global Footprint Network (2023).

COUNTRY	YEAR	GHGN	FDI	TOP	POLSTAB
Angola	2000	0.53	9.62	98.35	-2.04
Angola	2001	0.50	24.01	101.36	-2.04
Angola	2002	0.43	11.41	105.30	-1.58

Angola	2003	0.45	20.08	103.90	-1.01
Angola	2004	0.42	9.33	103.58	-1.06
Angola	2005	0.32	-3.53	106.59	-0.89
Angola	2006	0.30	-0.07	94.63	-0.54
Angola	2007	0.28	-1.37	108.06	-0.67
Angola	2008	0.28	1.90	121.36	-0.36
Angola	2009	0.30	3.14	122.45	-0.35
Angola	2010	0.31	-3.85	104.12	-0.23
Angola	2011	0.32	-2.70	99.98	-0.37
Angola	2012	0.30	-1.14	91.80	-0.39
Angola	2013	0.33	-5.38	86.81	-0.39
Angola	2014	0.34	2.69	79.33	-0.33
Angola	2015	0.37	11.08	62.89	-0.51
Angola	2016	0.35	-0.34	53.37	-0.32
Angola	2017	0.32	-10.04	52.26	-0.39
Angola	2018	0.30	-8.13	66.38	-0.35
Angola	2019	0.32	-5.78	57.83	-0.37
Angola	2020	0.25	-3.85	65.94	-0.60
Angola	2021	0.31	-6.55	74.46	-0.71
Angola	2022	0.32	-6.32	69.69	-0.63
Angola	2023	0.33	-2.50	67.04	-0.34
Benin	2000	0.25	-0.36	47.35	0.80
Benin	2001	0.28	0.46	48.26	0.80
Benin	2002	0.31	-0.46	43.77	0.82
Benin	2003	0.34	0.20	41.62	0.68
Benin	2004	0.35	-0.66	39.90	0.27
Benin	2005	0.37	-0.13	39.10	0.45
Benin	2006	0.49	-0.18	39.77	0.55
Benin	2007	0.53	1.70	49.11	0.39
Benin	2008	0.50	0.49	47.78	0.38
Benin	2009	0.53	-0.19	44.70	0.40
Benin	2010	0.56	0.56	51.43	0.26
Benin	2011	0.53	1.51	47.22	0.32
Benin	2012	0.48	2.53	50.74	0.36
Benin	2013	0.47	2.88	59.20	0.30
Benin	2014	0.49	3.05	65.27	0.03
Benin	2015	0.51	1.32	56.76	-0.02
Benin	2016	0.61	1.11	58.99	-0.01
Benin	2017	0.58	1.58	61.48	0.03
Benin	2018	0.62	1.36	61.80	-0.15
Benin	2019	0.57	1.52	63.68	-0.42
Benin	2020	0.58	1.11	44.83	-0.44
Benin	2021	0.41	1.96	48.05	-0.40

Benin	2022	0.39	2.16	50.93	-0.34
Benin	2023	0.36	2.20	51.35	-0.35
Botswana	2000	0.48	0.99	91.92	1.07
Botswana	2001	0.46	0.56	87.53	1.07
Botswana	2002	0.46	7.50	91.84	0.87
Botswana	2003	0.44	5.57	85.83	1.10
Botswana	2004	0.42	4.36	91.00	0.92
Botswana	2005	0.43	4.24	88.51	1.06
Botswana	2006	0.38	4.91	86.61	1.02
Botswana	2007	0.38	4.68	98.50	1.06
Botswana	2008	0.38	4.85	99.01	1.03
Botswana	2009	0.40	2.06	88.48	0.95
Botswana	2010	0.30	1.73	94.64	0.99
Botswana	2011	0.33	1.94	98.96	1.06
Botswana	2012	0.29	1.05	111.88	1.10
Botswana	2013	0.41	0.47	125.78	1.10
Botswana	2014	0.50	3.33	119.50	1.01
Botswana	2015	0.52	2.80	112.90	1.03
Botswana	2016	0.47	0.94	100.46	0.98
Botswana	2017	0.49	1.62	81.92	1.01
Botswana	2018	0.52	1.68	87.46	0.96
Botswana	2019	0.45	0.56	83.09	1.10
Botswana	2020	0.41	0.21	77.66	1.01
Botswana	2021	0.40	-1.70	88.76	1.04
Botswana	2022	0.42	3.49	85.61	1.07
Botswana	2023	0.41	3.43	68.86	1.04
Burkina Faso	2000	0.17	0.78	35.12	0.06
Burkina Faso	2001	0.19	0.20	31.66	0.06
Burkina Faso	2002	0.19	0.41	31.31	-0.31
Burkina Faso	2003	0.20	0.61	30.37	0.07
Burkina Faso	2004	0.17	0.26	35.48	-0.08
Burkina Faso	2005	0.16	0.85	34.17	-0.06
Burkina Faso	2006	0.16	1.28	35.11	0.16
Burkina Faso	2007	0.21	0.28	33.78	0.31
Burkina Faso	2008	0.23	0.35	35.39	0.12
Burkina Faso	2009	0.22	0.60	40.30	0.03
Burkina Faso	2010	0.22	0.38	49.07	-0.12
Burkina Faso	2011	0.23	1.19	57.50	-0.56
Burkina Faso	2012	0.25	2.62	61.24	-0.57
Burkina Faso	2013	0.28	3.65	64.04	-0.76
Burkina Faso	2014	0.24	2.56	58.82	-0.79
Burkina Faso	2015	0.33	1.96	59.09	-0.61
Burkina Faso	2016	0.31	3.04	57.89	-0.87

Burkina Faso	2017	0.33	0.02	59.27	-0.93
Burkina Faso	2018	0.35	1.69	60.60	-1.06
Burkina Faso	2019	0.37	1.02	60.41	-1.30
Burkina Faso	2020	0.36	-0.56	60.74	-1.54
Burkina Faso	2021	0.36	-0.41	62.42	-1.64
Burkina Faso	2022	0.37	3.56	64.84	-1.82
Burkina Faso	2023	0.35	0.54	64.82	-2.04
Cabo Verde	2000	0.31	6.34	87.52	1.22
Cabo Verde	2001	0.34	1.60	92.16	1.22
Cabo Verde	2002	0.36	2.38	101.09	0.73
Cabo Verde	2003	0.35	4.82	98.77	0.92
Cabo Verde	2004	0.34	7.31	101.57	1.04
Cabo Verde	2005	0.50	8.28	104.34	0.75
Cabo Verde	2006	0.51	11.88	117.82	0.96
Cabo Verde	2007	0.49	11.62	94.21	0.88
Cabo Verde	2008	0.45	10.76	90.97	0.81
Cabo Verde	2009	0.44	6.80	80.46	0.82
Cabo Verde	2010	0.46	6.37	85.55	0.84
Cabo Verde	2011	0.52	5.00	90.56	0.72
Cabo Verde	2012	0.44	6.69	90.65	0.81
Cabo Verde	2013	0.43	4.40	86.17	0.78
Cabo Verde	2014	0.45	8.84	91.30	0.35
Cabo Verde	2015	0.45	5.49	94.01	0.86
Cabo Verde	2016	0.45	6.83	95.38	0.87
Cabo Verde	2017	0.46	5.59	100.05	0.76
Cabo Verde	2018	0.44	4.70	105.87	0.83
Cabo Verde	2019	0.44	5.46	103.60	0.86
Cabo Verde	2020	0.58	3.71	78.39	0.87
Cabo Verde	2021	0.55	4.46	77.46	0.89
Cabo Verde	2022	0.50	5.43	96.99	0.93
Cabo Verde	2023	0.46	6.26	94.74	0.90
Cameroon	2000	0.33	1.51	47.93	-0.56
Cameroon	2001	0.32	-0.11	51.57	-0.56
Cameroon	2002	0.30	4.07	48.48	-0.68
Cameroon	2003	0.29	2.10	40.24	-0.43
Cameroon	2004	0.27	0.36	41.84	-0.36
Cameroon	2005	0.25	1.25	45.00	-0.18
Cameroon	2006	0.25	0.28	47.10	-0.24
Cameroon	2007	0.29	0.79	53.22	-0.33
Cameroon	2008	0.29	0.08	56.92	-0.55
Cameroon	2009	0.31	2.67	42.18	-0.47
Cameroon	2010	0.31	1.95	47.24	-0.74
Cameroon	2011	0.28	2.13	51.52	-0.66

Cameroon	2012	0.27	1.75	50.04	-0.59
Cameroon	2013	0.28	1.62	49.67	-0.53
Cameroon	2014	0.29	1.99	50.83	-1.06
Cameroon	2015	0.28	2.16	45.54	-0.99
Cameroon	2016	0.29	1.96	40.64	-1.06
Cameroon	2017	0.28	2.26	39.20	-1.09
Cameroon	2018	0.29	1.91	40.59	-1.40
Cameroon	2019	0.27	2.58	43.38	-1.56
Cameroon	2020	0.28	1.66	33.74	-1.51
Cameroon	2021	0.26	2.14	36.73	-1.39
Cameroon	2022	0.27	2.09	41.29	-1.38
Cameroon	2023	0.26	1.67	37.22	-1.40
Cote d'Ivoire	2000	0.23	1.42	54.96	-1.24
Cote d'Ivoire	2001	0.23	1.62	53.11	-1.24
Cote d'Ivoire	2002	0.26	1.18	55.90	-1.92
Cote d'Ivoire	2003	0.21	0.78	53.26	-1.80
Cote d'Ivoire	2004	0.21	1.20	58.12	-2.11
Cote d'Ivoire	2005	0.22	1.45	62.82	-2.26
Cote d'Ivoire	2006	0.21	1.39	63.69	-1.86
Cote d'Ivoire	2007	0.21	1.54	61.43	-1.84
Cote d'Ivoire	2008	0.22	1.37	61.94	-1.80
Cote d'Ivoire	2009	0.20	1.17	66.67	-1.32
Cote d'Ivoire	2010	0.21	1.03	67.47	-1.58
Cote d'Ivoire	2011	0.22	0.82	64.72	-1.41
Cote d'Ivoire	2012	0.26	0.91	70.30	-1.26
Cote d'Ivoire	2013	0.25	0.95	58.35	-1.05
Cote d'Ivoire	2014	0.24	0.90	53.68	-1.04
Cote d'Ivoire	2015	0.25	1.08	52.71	-0.84
Cote d'Ivoire	2016	0.23	1.19	47.57	-0.91
Cote d'Ivoire	2017	0.23	1.86	48.66	-1.09
Cote d'Ivoire	2018	0.22	1.06	46.04	-0.90
Cote d'Ivoire	2019	0.22	1.41	44.66	-1.04
Cote d'Ivoire	2020	0.22	1.13	41.94	-1.03
Cote d'Ivoire	2021	0.23	1.91	45.11	-0.72
Cote d'Ivoire	2022	0.22	2.28	53.43	-0.59
Cote d'Ivoire	2023	0.20	2.22	52.57	-0.63
Ghana	2000	0.30	3.33	116.05	-0.36
Ghana	2001	0.32	1.68	110.05	-0.36
Ghana	2002	0.36	0.96	97.49	-0.16
Ghana	2003	0.32	1.79	97.29	0.03
Ghana	2004	0.28	1.57	99.67	0.04
Ghana	2005	0.28	1.35	98.17	0.17
Ghana	2006	0.32	3.05	64.52	0.01

Ghana	2007	0.32	5.57	65.35	-0.07
Ghana	2008	0.28	9.47	69.51	-0.03
Ghana	2009	0.31	9.11	71.59	0.03
Ghana	2010	0.32	7.85	75.38	0.03
Ghana	2011	0.30	8.26	86.30	0.17
Ghana	2012	0.33	7.98	93.17	0.13
Ghana	2013	0.33	5.14	60.76	0.06
Ghana	2014	0.31	6.14	63.84	-0.11
Ghana	2015	0.32	6.46	76.52	-0.04
Ghana	2016	0.32	6.21	67.88	-0.14
Ghana	2017	0.31	5.39	70.55	0.08
Ghana	2018	0.33	4.44	67.96	-0.04
Ghana	2019	0.32	5.68	76.82	0.12
Ghana	2020	0.35	2.68	66.58	0.17
Ghana	2021	0.38	3.19	62.71	0.07
Ghana	2022	0.36	1.92	70.12	-0.20
Ghana	2023	0.34	1.73	69.04	-0.02
Kenya	2000	0.24	0.87	53.31	-1.07
Kenya	2001	0.22	0.04	55.95	-1.07
Kenya	2002	0.21	0.21	55.17	-1.19
Kenya	2003	0.18	0.55	54.13	-1.26
Kenya	2004	0.19	0.29	59.48	-1.09
Kenya	2005	0.21	0.11	64.48	-1.25
Kenya	2006	0.22	0.20	55.24	-1.13
Kenya	2007	0.20	2.28	53.89	-1.31
Kenya	2008	0.21	0.27	57.58	-1.39
Kenya	2009	0.24	0.27	45.95	-1.43
Kenya	2010	0.24	0.39	50.39	-1.17
Kenya	2011	0.24	3.09	58.40	-1.24
Kenya	2012	0.21	2.45	51.62	-1.32
Kenya	2013	0.23	1.81	47.46	-1.17
Kenya	2014	0.25	1.20	46.17	-1.28
Kenya	2015	0.25	0.88	40.33	-1.24
Kenya	2016	0.26	0.63	34.87	-1.35
Kenya	2017	0.26	1.64	36.00	-1.13
Kenya	2018	0.24	0.83	34.41	-1.18
Kenya	2019	0.23	0.47	31.76	-1.11
Kenya	2020	0.23	-0.01	27.24	-1.01
Kenya	2021	0.24	0.38	30.82	-1.03
Kenya	2022	0.23	0.69	33.69	-0.95
Kenya	2023	0.22	0.67	32.09	-0.94
Mauritius	2000	0.36	5.62	120.69	0.75
Mauritius	2001	0.37	-0.59	128.05	0.75

Mauritius	2002	0.37	0.65	118.23	1.12
Mauritius	2003	0.37	1.06	108.66	1.01
Mauritius	2004	0.36	0.21	107.03	0.97
Mauritius	2005	0.37	0.64	121.61	1.03
Mauritius	2006	0.40	1.52	127.06	0.78
Mauritius	2007	0.39	4.18	120.88	0.88
Mauritius	2008	0.38	3.78	115.49	0.89
Mauritius	2009	0.36	2.81	104.43	0.71
Mauritius	2010	0.37	4.30	113.46	0.64
Mauritius	2011	0.35	3.76	117.54	0.95
Mauritius	2012	0.35	5.05	119.50	0.97
Mauritius	2013	0.35	2.39	113.31	0.94
Mauritius	2014	0.34	3.48	110.59	0.67
Mauritius	2015	0.33	1.80	107.15	0.99
Mauritius	2016	0.33	3.01	101.37	1.00
Mauritius	2017	0.33	3.50	101.25	0.96
Mauritius	2018	0.31	3.13	98.09	0.86
Mauritius	2019	0.30	3.08	96.49	0.80
Mauritius	2020	0.32	1.97	85.83	0.87
Mauritius	2021	0.33	2.20	98.00	0.83
Mauritius	2022	0.30	4.48	118.34	0.83
Mauritius	2023	0.30	5.19	107.90	0.78
Namibia	2000	0.35	5.01	85.13	-0.25
Namibia	2001	0.43	10.66	88.58	-0.25
Namibia	2002	0.36	4.41	94.42	0.15
Namibia	2003	0.37	1.32	95.95	0.48
Namibia	2004	0.35	3.38	81.86	0.66
Namibia	2005	0.36	5.38	80.68	0.63
Namibia	2006	0.33	7.63	86.83	0.78
Namibia	2007	0.33	7.57	104.98	1.02
Namibia	2008	0.36	8.72	119.64	1.20
Namibia	2009	0.37	9.27	123.76	0.93
Namibia	2010	0.36	2.52	108.07	0.85
Namibia	2011	0.37	6.42	102.19	0.91
Namibia	2012	0.37	7.99	100.21	0.98
Namibia	2013	0.37	6.45	97.72	0.96
Namibia	2014	0.36	3.58	103.08	0.61
Namibia	2015	0.36	7.40	97.24	0.73
Namibia	2016	0.38	3.35	93.97	0.70
Namibia	2017	0.37	2.18	81.22	0.62
Namibia	2018	0.37	1.71	81.71	0.69
Namibia	2019	0.38	-1.41	82.90	0.53
Namibia	2020	0.38	-1.42	76.93	0.51

Namibia	2021	0.37	6.78	83.54	0.52
Namibia	2022	0.38	8.40	99.11	0.56
Namibia	2023	0.37	18.58	109.61	0.54
Niger	2000	0.16	0.70	34.71	0.12
Niger	2001	0.15	0.92	33.01	0.12
Niger	2002	0.14	0.28	30.83	-0.13
Niger	2003	0.15	0.55	33.38	0.04
Niger	2004	0.16	0.65	36.96	-0.51
Niger	2005	0.14	1.14	38.35	-0.49
Niger	2006	0.14	0.85	36.53	-0.23
Niger	2007	0.14	1.73	35.50	-0.46
Niger	2008	0.14	3.88	39.71	-0.67
Niger	2009	0.17	8.62	49.51	-1.15
Niger	2010	0.20	10.15	51.95	-1.16
Niger	2011	0.20	12.16	50.25	-0.88
Niger	2012	0.25	8.92	45.09	-1.15
Niger	2013	0.23	7.04	46.30	-1.32
Niger	2014	0.24	7.58	45.74	-1.18
Niger	2015	0.22	5.47	44.73	-1.06
Niger	2016	0.21	2.90	36.49	-1.10
Niger	2017	0.18	3.03	39.07	-1.26
Niger	2018	0.18	3.63	37.54	-1.36
Niger	2019	0.19	5.56	37.10	-1.41
Niger	2020	0.19	2.62	35.51	-1.67
Niger	2021	0.22	3.99	37.02	-1.54
Niger	2022	0.20	6.26	31.33	-1.46
Niger	2023	0.19	6.10	30.42	-1.67
Nigeria	2000	0.56	1.65	49.00	-1.46
Nigeria	2001	0.56	1.62	49.68	-1.46
Nigeria	2002	0.44	1.97	40.04	-1.63
Nigeria	2003	0.46	1.91	49.33	-1.64
Nigeria	2004	0.40	1.38	31.90	-1.75
Nigeria	2005	0.38	2.84	33.06	-1.67
Nigeria	2006	0.32	2.04	42.57	-2.03
Nigeria	2007	0.27	2.17	39.34	-2.01
Nigeria	2008	0.28	2.41	40.80	-1.86
Nigeria	2009	0.23	2.90	36.06	-1.99
Nigeria	2010	0.25	1.64	43.32	-2.21
Nigeria	2011	0.26	2.13	53.28	-1.96
Nigeria	2012	0.24	1.52	44.53	-2.04
Nigeria	2013	0.26	1.07	31.05	-2.09
Nigeria	2014	0.26	0.82	30.89	-2.13
Nigeria	2015	0.24	0.62	21.33	-1.92

Nigeria	2016	0.25	0.85	20.72	-1.87
Nigeria	2017	0.24	0.64	26.35	-2.00
Nigeria	2018	0.25	0.18	33.01	-2.10
Nigeria	2019	0.25	0.49	34.02	-1.93
Nigeria	2020	0.24	0.55	31.85	-1.89
Nigeria	2021	0.25	0.75	35.83	-1.79
Nigeria	2022	0.24	-0.04	36.03	-1.78
Nigeria	2023	0.23	0.51	35.99	-1.77
Senegal	2000	0.38	1.36	48.68	-0.59
Senegal	2001	0.41	0.69	49.72	-0.59
Senegal	2002	0.43	1.18	53.14	-0.27
Senegal	2003	0.39	0.99	50.82	-0.25
Senegal	2004	0.43	1.37	53.66	0.03
Senegal	2005	0.46	1.53	54.90	-0.20
Senegal	2006	0.44	2.48	54.14	-0.26
Senegal	2007	0.47	2.51	59.27	-0.24
Senegal	2008	0.47	2.70	62.76	-0.15
Senegal	2009	0.47	2.05	52.31	-0.21
Senegal	2010	0.48	1.69	52.46	-0.42
Senegal	2011	0.51	1.90	57.58	-0.28
Senegal	2012	0.48	1.56	61.98	-0.11
Senegal	2013	0.50	1.65	60.63	-0.06
Senegal	2014	0.50	2.04	58.44	-0.20
Senegal	2015	0.52	2.30	58.11	-0.12
Senegal	2016	0.54	2.48	54.11	-0.23
Senegal	2017	0.50	2.80	57.71	-0.06
Senegal	2018	0.50	3.67	61.79	-0.11
Senegal	2019	0.49	4.55	64.24	0.04
Senegal	2020	0.47	7.52	60.05	-0.14
Senegal	2021	0.50	9.40	69.38	-0.18
Senegal	2022	0.49	10.60	80.03	-0.16
Senegal	2023	0.45	15.53	71.00	-0.14
South Africa	2000	1.57	0.64	46.22	-0.23
South Africa	2001	1.57	5.37	49.17	-0.23
South Africa	2002	1.57	1.15	53.47	-0.25
South Africa	2003	1.62	0.40	45.72	-0.31
South Africa	2004	1.68	0.27	45.64	-0.13
South Africa	2005	1.63	2.26	47.43	-0.16
South Africa	2006	1.56	0.21	53.77	0.05
South Africa	2007	1.55	1.98	57.13	0.22
South Africa	2008	1.59	3.13	65.97	0.05
South Africa	2009	1.51	2.31	49.59	-0.11
South Africa	2010	1.49	0.88	50.41	-0.03

South Africa	2011	1.38	0.90	54.64	0.02
South Africa	2012	1.40	1.06	55.58	-0.03
South Africa	2013	1.40	2.05	58.88	-0.05
South Africa	2014	1.41	1.52	59.50	-0.15
South Africa	2015	1.33	0.44	56.73	-0.22
South Africa	2016	1.32	0.68	55.86	-0.15
South Africa	2017	1.33	0.54	53.54	-0.28
South Africa	2018	1.32	1.37	54.49	-0.24
South Africa	2019	1.33	1.31	53.90	-0.28
South Africa	2020	1.24	0.93	50.76	-0.25
South Africa	2021	1.21	9.66	56.03	-0.75
South Africa	2022	1.13	2.27	64.78	-0.68
South Africa	2023	1.09	0.90	65.18	-0.67
Tanzania	2000	0.17	3.47	23.99	-0.70
Tanzania	2001	0.17	4.05	28.03	-0.70
Tanzania	2002	0.18	2.80	27.50	-0.25
Tanzania	2003	0.18	2.09	30.45	-0.86
Tanzania	2004	0.23	2.65	33.61	-0.67
Tanzania	2005	0.24	5.09	36.96	-0.58
Tanzania	2006	0.24	2.16	42.77	-0.36
Tanzania	2007	0.21	2.66	48.06	-0.39
Tanzania	2008	0.20	4.95	49.03	-0.23
Tanzania	2009	0.19	3.24	43.53	0.09
Tanzania	2010	0.21	5.66	47.64	0.01
Tanzania	2011	0.24	3.55	56.17	-0.02
Tanzania	2012	0.27	4.54	54.37	0.05
Tanzania	2013	0.28	4.57	48.63	-0.16
Tanzania	2014	0.25	2.83	45.36	-0.60
Tanzania	2015	0.28	3.18	40.76	-0.42
Tanzania	2016	0.28	1.74	35.42	-0.45
Tanzania	2017	0.26	1.76	33.11	-0.57
Tanzania	2018	0.26	1.70	32.64	-0.58
Tanzania	2019	0.28	1.99	33.02	-0.39
Tanzania	2020	0.27	1.43	27.96	-0.48
Tanzania	2021	0.30	1.68	29.92	-0.34
Tanzania	2022	0.28	1.90	35.00	-0.26
Tanzania	2023	0.27	2.06	38.21	-0.05
Togo	2000	0.36	2.51	48.81	-0.29
Togo	2001	0.32	3.47	51.39	-0.29
Togo	2002	0.33	2.40	51.61	0.06
Togo	2003	0.37	1.53	55.39	-0.19
Togo	2004	0.36	2.51	57.87	-0.31
Togo	2005	0.36	2.98	61.45	-1.44

Togo	2006	0.32	2.75	61.61	-0.53
Togo	2007	0.33	1.66	60.93	-0.34
Togo	2008	0.41	1.11	61.44	-0.17
Togo	2009	0.66	0.98	61.33	-0.17
Togo	2010	0.58	2.63	65.86	-0.18
Togo	2011	0.50	13.44	76.66	-0.16
Togo	2012	0.45	2.24	74.61	-0.39
Togo	2013	0.37	3.05	80.99	-0.35
Togo	2014	0.32	0.84	69.92	-0.17
Togo	2015	0.27	4.48	68.20	-0.23
Togo	2016	0.35	-0.76	65.53	-0.18
Togo	2017	0.29	1.39	57.60	-0.87
Togo	2018	0.30	-2.57	57.36	-0.89
Togo	2019	0.29	4.94	56.14	-0.91
Togo	2020	0.32	-0.80	55.55	-0.89
Togo	2021	0.33	-1.63	57.59	-0.70
Togo	2022	0.32	-2.12	65.49	-0.79
Togo	2023	0.30	0.37	61.43	-0.95
Uganda	2000	0.12	2.59	32.75	-1.25
Uganda	2001	0.11	2.59	35.33	-1.25
Uganda	2002	0.12	2.99	36.28	-1.42
Uganda	2003	0.12	3.06	36.59	-1.56
Uganda	2004	0.11	3.72	35.46	-1.30
Uganda	2005	0.13	4.11	38.99	-1.42
Uganda	2006	0.14	6.46	43.63	-1.14
Uganda	2007	0.15	6.66	46.78	-0.92
Uganda	2008	0.15	5.05	56.26	-0.88
Uganda	2009	0.16	3.35	47.06	-0.99
Uganda	2010	0.15	2.04	38.27	-1.00
Uganda	2011	0.15	3.21	39.76	-0.98
Uganda	2012	0.15	4.41	43.50	-0.87
Uganda	2013	0.14	3.79	43.11	-0.84
Uganda	2014	0.15	3.25	36.01	-0.94
Uganda	2015	0.17	2.28	37.69	-0.80
Uganda	2016	0.17	2.14	31.21	-0.72
Uganda	2017	0.17	2.61	36.84	-0.57
Uganda	2018	0.18	3.21	36.64	-0.70
Uganda	2019	0.17	3.69	39.36	-0.69
Uganda	2020	0.17	3.17	37.00	-0.81
Uganda	2021	0.18	4.07	41.71	-0.94
Uganda	2022	0.16	6.48	34.51	-0.71
Uganda	2023	0.16	6.13	33.34	-0.70
Zambia	2000	0.24	3.38	60.39	0.04

Zambia	2001	0.23	3.54	64.67	0.04
Zambia	2002	0.23	7.11	64.92	-0.27
Zambia	2003	0.24	7.08	62.31	0.22
Zambia	2004	0.23	5.85	70.81	0.19
Zambia	2005	0.23	4.28	62.20	0.11
Zambia	2006	0.20	4.83	57.86	0.36
Zambia	2007	0.17	9.42	65.77	0.36
Zambia	2008	0.17	5.24	59.45	0.47
Zambia	2009	0.18	4.53	56.12	0.57
Zambia	2010	0.18	8.53	65.01	0.52
Zambia	2011	0.19	4.73	72.80	0.51
Zambia	2012	0.23	6.79	75.37	0.66
Zambia	2013	0.23	7.49	80.46	0.44
Zambia	2014	0.24	5.56	76.19	0.16
Zambia	2015	0.25	7.45	79.87	0.14
Zambia	2016	0.26	3.16	73.96	0.13
Zambia	2017	0.31	4.28	71.59	0.14
Zambia	2018	0.34	1.55	74.89	0.08
Zambia	2019	0.29	2.35	68.79	-0.12
Zambia	2020	0.32	1.35	79.21	-0.13
Zambia	2021	0.31	1.78	86.21	0.05
Zambia	2022	0.30	-0.22	69.30	0.16
Zambia	2023	0.29	0.31	78.24	0.20

Appendix II: Results

Dependent Variable: LRGDP

Method: Panel Least Squares
Date: 04/19/25 Time: 13:35
Sample: 2000 2023
Periods included: 24
Cross-sections included: 19
Total panel (balanced) observations: 456

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.630767	0.433479	17.60353	0.0000
IPR	1.673719	0.185431	9.026097	0.0000
LIND	0.481162	0.079221	6.073652	0.0000
GIP	0.039756	0.007452	5.334982	0.0000
CO2PC	-0.288090	0.075754	-3.802956	0.0002
GHGN	0.169690	0.367399	0.461869	0.6444
FDI	-0.024545	0.012123	-2.024600	0.0435
TOP	-0.008504	0.002479	-3.431021	0.0007
POLSTAB	-1.044138	0.057487	-18.16291	0.0000

Effects Specification

Period fixed (dummy variables)

R-squared	0.677045	Mean dependent var	9.998553
Adjusted R-squared	0.653433	S.D. dependent var	1.331361
S.E. of regression	0.783771	Akaike info criterion	2.418193
Sum squared resid	260.4622	Schwarz criterion	2.707490
Log likelihood	-519.3479	Hannan-Quinn criter.	2.532153
F-statistic	28.67349	Durbin-Watson stat	0.107746
Prob(F-statistic)	0.000000		

Dependent Variable: D(LRGDP)
Method: ARDL
Date: 04/19/25 Time: 13:36
Sample: 2001 2023

Included observations: 437
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): IPR LIND GIP CO2PC
GHGN FDI TOP POLSTAB
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 256
Selected model: PMG(1,1,1,0,1,1,1,0,1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
IPR	0.134564	0.301037	7.090712	0.0000
LIND	0.584216	0.089108	6.556246	0.0000
GIP	0.165217	0.064015	2.580920	0.0102
CO_2PC	-2.855870	0.360452	-7.923028	0.0000
GHGN	1.896298	0.900090	2.106789	0.0357
FDI	0.059365	0.016006	3.708863	0.0002
TOP	0.009689	0.003141	3.084658	0.0022
POLSTAB	0.052919	0.095430	0.554530	0.5795
C	10.45032	0.746900	13.99160	0.0000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.059326	0.021233	-2.258166	0.0290
D(IPR)	-0.017805	0.015592	-1.141928	0.2541
D(LIND)	0.009248	0.007100	1.302479	0.1934
D(CO_2PC)	-2.291371	0.557135	-4.112775	0.0000
D(GHGN)	-2.534578	0.259137	-9.780826	0.0000
D(FDI)	-0.000253	0.000776	-0.326401	0.7443
D(POLSTAB)	0.004976	0.003616	1.376020	0.1695
Log-Likelihood:	1437.029			

Dependent Variable: D(LRGDP)
Method: ARDL
Date: 04/19/25 Time: 13:41

Sample: 2002 2023
Included observations: 418
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (2 max. lags): IPR LIND GIP FDI TOP
POLSTAB
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 729
Selected model: PMG(1,2,2,2,2,1,2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
IPR	4.691816	0.334358	14.03232	0.0000
LIND	0.454441	0.059536	7.633045	0.0000
GIP	0.090381	0.015989	5.652523	0.0000
FDI	0.095125	0.013952	6.817982	0.0000
TOP	0.019255	0.002617	7.357465	0.0000
POLSTAB	0.182632	0.051037	3.578412	0.0004
C	11.25778	0.442795	25.42433	0.0000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.049301	0.022686	-2.386334	0.0215
D(IPR)	-0.178578	0.081103	-2.201869	0.0282
D(IPR(-1))	-0.077896	0.082000	-0.949954	0.3427
D(LIND)	0.097167	0.027062	3.590593	0.0004
D(LIND(-1))	0.062410	0.026011	2.399321	0.0169
D(GIP)	-0.008794	0.021001	-0.418729	0.6756
D(GIP(-1))	-0.010377	0.021627	-0.479807	0.6316
D(FDI)	0.004771	0.003183	1.499089	0.1346
D(FDI(-1))	0.004841	0.002833	1.708990	0.0882
D(TOP)	8.37E-05	0.000841	0.099576	0.9207
D(POLSTAB)	0.003722	0.019386	0.191996	0.8478
D(POLSTAB(-1))	0.001134	0.019781	0.057340	0.9543
Log-Likelihood:	1144.855			

Dependent Variable: D(LRGDP)
Method: ARDL

Date: 04/19/25 Time: 13:47
Sample: 2001 2023
Included observations: 437
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (2 max. lags): CO_2PC GHGN FDI TOP
POLSTAB
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 243
Selected model: PMG(1,1,1,0,0,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
CO_2PC	-0.658106	0.089220	-7.376214	0.0000
GHGN	3.339320	0.564852	5.911846	0.0000
FDI	0.066956	0.012179	5.497673	0.0000
TOP	-0.018050	0.002033	-8.878392	0.0000
POLSTAB	0.704666	0.077729	9.065667	0.0000
C	11.65376	0.191801	60.75972	0.0000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.061073	0.028145	-0.887161	0.0335
D(CO_2PC)	2.478669	0.592823	4.181127	0.0000
D(GHGN)	-2.735058	0.269239	-10.15849	0.0000
Log-Likelihood:	1327.965			

Dependent Variable: D(LRGDP)
Method: ARDL

Date: 04/19/25 Time: 14:01
Sample: 2001 2023
Included observations: 437
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): IPR IND GIP IPR_CO2 FDI
TOP POLSTAB
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 128
Selected model: PMG(1,1,1,0,1,0,1,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long-run (Pooled) Coefficients				
IPR	3.868094	0.834414	4.635701	0.0000
IND	-0.165221	0.131413	-1.258606	0.2089
GIP	-0.242227	0.090942	-2.663524	0.0080
IPR_CO_2	1.559653	0.524217	2.975206	0.0031
FDI	0.210724	0.058275	3.616064	0.0003
TOP	0.025804	0.010167	2.537983	0.0115
POLSTAB	0.082101	0.207009	0.396608	0.6919
C	14.02353	0.556717	25.18971	0.0000
Short-run (Mean-Group) Coefficients				
COINTEQ	-0.009133	0.002530	-3.610012	0.0003
D(IPR)	0.235848	0.043306	5.446020	0.0000
D(IND)	0.090805	0.025514	3.556941	0.0004
D(IPR_CO_2)	0.289720	0.138125	2.097515	0.0365
D(TOP)	0.000271	0.000351	0.772970	0.4400
Log-Likelihood:	1109.321			

Dependent Variable: D(LRGDP)
Method: ARDL
Date: 04/19/25 Time: 14:05

Sample: 2001 2023
Included observations: 437
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): IPR IND GIP GIP_GHG FDI
TOP POLSTAB
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 128
Selected model: PMG(1,0,1,0,1,0,1,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
IPR	2.652890	0.460342	5.762867	0.0000
IND	-0.088005	0.095214	-0.924641	0.3557
GIP	0.164788	0.082574	1.995648	0.0466
GIP_GHG	0.081502	0.129509	0.629315	0.5295
FDI	0.078473	0.016335	4.803920	0.0000
TOP	-0.015103	0.003335	-4.528155	0.0000
POLSTAB	0.608280	0.100376	6.060005	0.0000
C	13.77362	0.397181	34.67846	0.0000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.012136	0.008248	-1.471346	0.1419
D(IND)	0.052205	0.021683	2.412530	0.0163
D(GIP_GHG)	0.045627	0.022283	2.084675	0.0418
D(TOP)	0.000564	0.000327	1.723974	0.0854
Log-Likelihood:	1028.688			

Dependent Variable: D(LRGDP)
Method: ARDL

Date: 04/19/25   Time: 14:07
Sample: 2001 2023
Included observations: 437
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): IPR IND GIP
IND_GHG FDI
TOP POLSTAB
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 128
Selected model: PMG(1,1,1,0,1,1,0,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
IPR	1.888269	0.447036	4.223972	0.0000
IND	0.058921	0.030133	1.947219	0.0522
GIP	0.077512	0.033216	2.333560	0.0201
IND_GHG	-0.085101	0.097901	-0.870027	0.3848
FDI	0.168161	0.041070	4.094475	0.0001
TOP	0.014072	0.005832	2.412695	0.0163
POLSTAB	0.289777	0.149968	1.932258	0.0540
C	12.17436	0.358723	33.93810	0.0000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.009424	0.004766	-1.977340	0.0486
D(IPR)	-0.184577	0.073420	-2.513984	0.0123
D(IND)	0.013626	0.004655	2.935279	0.0035
D(IND_GHG)	-0.090105	0.125251	-0.718332	0.4729
D(FDI)	0.004442	0.002994	1.483682	0.1386
Log-Likelihood:	1065.538			

Dependent Variable: D(CO2PC)
Method: ARDL

Date: 04/19/25 Time: 14:09
Sample: 2002 2023
Included observations: 418
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (2 max. lags): LRGDP
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 3
Selected model: PMG(1,2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
LRGDP	0.069427	0.012204	5.689087	0.0000
C	-0.372119	0.132991	-2.798070	0.0054
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.107001	0.027117	-3.945824	0.0001
D(LRGDP)	1.079723	0.600498	1.798047	0.0729
D(LRGDP(-1))	0.264381	0.160550	1.646721	0.1004
Log-Likelihood:	786.6945			

Dependent Variable: D(CO2PC)
Method: ARDL

Date: 04/19/25 Time: 14:10
Sample: 2002 2023
Included observations: 418
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (2 max. lags): LRGDP
LRGDP^2
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 9
Selected model: PMG(1,2,1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long-run (Pooled) Coefficients				
LRGDP	0.321685	0.163458	1.967995	0.0497
LRGDP^2	-0.125338	0.607981	-2.245918	0.0229
C	-1.577565	0.830880	-1.898668	0.0583
Short-run (Mean-Group) Coefficients				
COINTEQ	-0.126259	0.033801	-3.735354	0.0002
D(LRGDP)	3.195740	9.483856	0.336966	0.7363
D(LRGDP(-1))	0.161548	0.160118	1.008929	0.3136
D(LRGDP^2)	-0.054060	0.404551	-0.133631	0.8938
Log-Likelihood:	809.8973			

Dependent Variable: D(GHGN)

Method: ARDL
Date: 04/19/25 Time: 20:48
Sample: 2001 2023
Included observations: 437
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (3 max. lags): LRGDP
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 4
Selected model: PMG(1,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			
LRGDP	-0.064189	0.007276	-8.822358	0.0000
C	0.938681	0.069565	13.49362	0.0000
	Short-run (Mean-Group) Coefficients			
COINTEQ	-0.131164	0.031355	-4.183169	0.0000
Log-Likelihood:	1000.656			

Dependent Variable: D(GHGN)
Method: ARDL
Date: 04/19/25 Time: 20:49
Sample: 2001 2023
Included observations: 437
Number of cross-sections: 19
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (3 max. lags): LRGDP LRGDP^2
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 16
Selected model: PMG(1,1,1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Long-run (Pooled) Coefficients			

LRGDP	-0.357072	0.164437	-2.171485	0.0304
LRGDP^2	0.016630	0.008312	2.000818	0.0460
C	2.251957	0.810269	2.779271	0.0057
		Short-run (Mean-Group) Coefficients		
COINTEQ	-0.181685	0.057909	-3.137414	0.0018
D(LRGDP)	0.399037	2.429143	0.164271	0.8696
D(LRGDP^2)	-0.028498	0.114956	-0.247904	0.8043
Log-Likelihood:	1053.336			

Null hypothesis: No levels relationship
Number of cointegrating variables: 19
Number of cointegrating variables: 8
Trend type: Rest. constant (Case 2)

Cross-Section	Obs.	F-Stat.
Angola	23	15.08269
Benin	23	14.19598
Botswana	23	2.291056
Burkina Faso	23	9.353021
Cabo Verde	23	3.078727
Cameroon	23	79.93073
Cote d'Ivoire	23	10.59279
Ghana	23	12.46778
Kenya	23	8.617799
Mauritius	23	9.523832
Namibia	23	26.30051
Niger	23	66.23607
Nigeria	23	15.60396
Senegal	23	14.57293
South Africa	23	8.972418
Tanzania	23	12.47253
Togo	23	10.79049
Uganda	23	11.79991
Zambia	23	28.17705

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Asymptotic	1.850	2.850	2.110	3.150	2.620	3.770

*** Finite sample critical values are valid up to 7 error-correction variables.

Null hypothesis: No levels relationship
Number of cointegrating variables: 19
Number of cointegrating variables: 5
Trend type: Rest. constant (Case 2)

Cross-Section	Obs.	F-Stat.
Angola	23	22.96072
Benin	23	37.97540
Botswana	23	4.818912
Burkina Faso	23	24.65830
Cabo Verde	23	5.726070
Cameroon	23	185.2618
Cote d'Ivoire	23	18.50802
Ghana	23	8.795957
Kenya	23	18.50192
Mauritius	23	9.318506
Namibia	23	38.78693
Niger	23	54.48514
Nigeria	23	21.97631
Senegal	23	40.97993
South Africa	23	21.80122
Tanzania	23	35.51912
Togo	23	9.726497
Uganda	23	33.81923
Zambia	23	49.43481

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	2.407	3.517	2.910	4.193	4.134	5.761
Asymptotic	2.080	3.000	2.390	3.380	3.060	4.150

* I(0) and I(1) are respectively the stationary and non-stationary bounds.

Pairwise Dumitrescu Hurlin Panel Causality Tests
Date: 04/19/25 Time: 14:13
Sample: 2000 2023
Lags: 2

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
IPR does not homogeneously cause LRGDP	2.84633	0.97479	0.3297
LRGDP does not homogeneously cause IPR	4.66509	4.03332	5.E-05
IND does not homogeneously cause LRGDP	3.05636	1.32799	0.1842
LRGDP does not homogeneously cause IND	4.80784	4.27337	2.E-05
GIP does not homogeneously cause LRGDP	2.02309	-0.40961	0.6821
LRGDP does not homogeneously cause GIP	5.15113	4.85067	1.E-06
CO2PC does not homogeneously cause LRGDP	2.13329	-0.22429	0.8225
LRGDP does not homogeneously cause CO2PC	4.68195	4.06166	5.E-05
GHGN does not homogeneously cause LRGDP	2.27602	0.01573	0.9874
LRGDP does not homogeneously cause GHGN	3.45196	1.99324	0.0462
IND does not homogeneously cause IPR	3.05376	1.32362	0.1856

IPR does not homogeneously cause IND	2.72083	0.76374	0.4450
GIP does not homogeneously cause IPR	3.87591	2.70619	0.0068
IPR does not homogeneously cause GIP	3.94547	2.82316	0.0048
CO2PC does not homogeneously cause IPR	3.42537	1.94853	0.0514
IPR does not homogeneously cause CO2PC	2.76792	0.84293	0.3993
GHGN does not homogeneously cause IPR	2.60449	0.56810	0.5700
IPR does not homogeneously cause GHGN	3.51093	2.09243	0.0364
GIP does not homogeneously cause IND	1.93497	-0.55779	0.5770
IND does not homogeneously cause GIP	3.45818	2.00372	0.0451
CO2PC does not homogeneously cause IND	3.68843	2.39091	0.0168
IND does not homogeneously cause CO2PC	4.05252	3.00319	0.0027
GHGN does not homogeneously cause IND	2.82271	0.93507	0.3498
IND does not homogeneously cause GHGN	3.21325	1.59183	0.1114
CO2PC does not homogeneously cause GIP	5.09338	4.75354	2.E-06
GIP does not homogeneously cause CO2PC	4.17955	3.21680	0.0013
GHGN does not homogeneously cause GIP	6.74635	7.53327	5.E-14
GIP does not homogeneously cause GHGN	3.55339	2.16381	0.0305
GHGN does not homogeneously cause CO2PC	4.78303	4.23165	2.E-05
CO2PC does not homogeneously cause GHGN	3.22160	1.60587	0.1083

Panel unit root test: Summary
Series: LRGDP
Date: 04/19/25 Time: 15:33
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-1.03667	0.0841	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.68883	0.9544	19	418
ADF - Fisher Chi-square	49.5885	0.0987	19	418
PP - Fisher Chi-square	59.7073	0.0138	19	437

** 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(LRGDP)
Date: 04/19/25 Time: 15:33
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-5.07872	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.57912	0.0000	19	399
ADF - Fisher Chi-square	100.359	0.0000	19	399
PP - Fisher Chi-square	217.852	0.0000	19	418

** Probabilities for Fisher tests are computed using an

asymptotic Chi
-square distribution. All other tests assume asymptotic normality.

Panel unit root test: Summary
Series: IPR
Date: 04/19/25 Time: 15:34
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.56360	0.2865	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.95594	0.1696	19	418
ADF - Fisher Chi-square	45.8604	0.1784	19	418
PP - Fisher Chi-square	56.7917	0.0255	19	437

** 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(IPR)
Date: 04/19/25 Time: 15:35
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-8.61854	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-	-10.7797	0.0000	19	399

stat				
ADF - Fisher Chi-square	186.426	0.0000	19	399
PP - Fisher Chi-square	349.923	0.0000	19	418

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

Panel unit root test: Summary
Series: IND
Date: 04/19/25 Time: 15:35
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-1.37245	0.0850	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.67302	0.7495	19	418
ADF - Fisher Chi-square	30.9198	0.7856	19	418
PP - Fisher Chi-square	21.8475	0.9834	19	437

** 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(IND)
Date: 04/19/25 Time: 15:35
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Cross-

Method	Statistic	Prob.**	sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.70045	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.74320	0.0000	19	399
ADF - Fisher Chi-square	134.050	0.0000	19	399
PP - Fisher Chi-square	243.735	0.0000	19	418

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

Panel unit root test: Summary
Series: GIP
Date: 04/19/25 Time: 15:36
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.11621	0.4537	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.58812	0.7218	19	418
ADF - Fisher Chi-square	40.8686	0.3456	19	418
PP - Fisher Chi-square	72.7412	0.0006	19	437

** 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(GIP)
Date: 04/19/25 Time: 15:36
Sample: 2000 2023

Exogenous variables: Individual effects
User-specified lags: 1
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*	-10.5845	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-10.6125	0.0000	19	399
ADF - Fisher Chi-square	180.645	0.0000	19	399
PP - Fisher Chi-square	573.139	0.0000	19	418

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

Panel unit root test: Summary
Series: CO2PC
Date: 04/19/25 Time: 15:36
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-1.34465	0.0894	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.03491	0.8496	19	418
ADF - Fisher Chi-square	27.0461	0.9073	19	418
PP - Fisher Chi-square	27.7507	0.8894	19	437

** 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(CO2PC)
Date: 04/19/25 Time: 15:37
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-4.84850	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.54618	0.0000	19	399
ADF - Fisher Chi-square	127.678	0.0000	19	399
PP - Fisher Chi-square	273.090	0.0000	19	418

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

Panel unit root test: Summary
Series: GHGN
Date: 04/19/25 Time: 15:37
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-4.28146	0.0000	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.70259	0.0034	19	418
ADF - Fisher Chi-square	73.8364	0.0004	19	418
PP - Fisher Chi-square	69.8429	0.0012	19	437

** 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(GHGN)
Date: 04/19/25 Time: 15:37
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-6.04813	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.99328	0.0000	19	399
ADF - Fisher Chi-square	152.989	0.0000	19	399
PP - Fisher Chi-square	308.048	0.0000	19	418

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

Panel unit root test: Summary
Series: FDI
Date: 04/19/25 Time: 15:38
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	1.58091	0.9431	19	418

Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.21054	0.1130	19	418
ADF - Fisher Chi-square	60.0824	0.0127	19	418
PP - Fisher Chi-square	92.4233	0.0000	19	437

** 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(FDI)
Date: 04/19/25 Time: 15:38
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-7.63414	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-11.3346	0.0000	19	399
ADF - Fisher Chi-square	202.571	0.0000	19	399
PP - Fisher Chi-square	733.094	0.0000	19	418

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

Panel unit root test: Summary
Series: TOP
Date: 04/19/25 Time: 15:39
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-2.22453	0.0131	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.75636	0.0395	19	418
ADF - Fisher Chi-square	48.8364	0.1120	19	418
PP - Fisher Chi-square	44.8986	0.2051	19	437

** 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(TOP)
Date: 04/19/25 Time: 15:39
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-10.3690	0.0000	19	399
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-10.8565	0.0000	19	399
ADF - Fisher Chi-square	185.852	0.0000	19	399
PP - Fisher Chi-square	303.465	0.0000	19	418

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

Panel unit root test: Summary
Series: POLSTAB
Date: 04/19/25 Time: 15:39
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-2.97382	0.0015	19	418
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.25685	0.0006	19	418
ADF - Fisher Chi-square	90.9152	0.0000	19	418
PP - Fisher Chi-square	99.6295	0.0000	19	437

** 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(POLSTAB)
Date: 04/19/25 Time: 15:40
Sample: 2000 2023
Exogenous variables: Individual effects
User-specified lags: 1
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*	-10.7539	0.0000	19	399

Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-12.4528	0.0000	19	399
ADF - Fisher Chi-square	213.229	0.0000	19	399
PP - Fisher Chi-square	412.668	0.0000	19	418

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

Panel unit root tests with cross-sectional dependence: Bai and Ng - PANIC
Series: LRGDP
Date: 04/19/25 Time: 15:40
Sample: 2000 2023
Cross-sections: 19
Balanced observations: 23
Total observations: 437
Deterministics: Constant
Probabilities simulated using 1000 obs. and 10000 Monte Carlo replications.
Common factors: Cardinality of non-stationary factors
Test variant: MQC
Null hypothesis: Retain common factors
Maximum factors: 7 (Schwert)
Factors selected: 7 (Bai and Ng: Average of criteria)
MQ significance level: 5%
Stationary factors: 0

Common trends	Test statistic	p-value
7	-0.65578	0.99990

Idiosyncratic elements: Pooled test
Null hypothesis: No cointegration among all cross-sections
Lag selection: AIC with maxlag=7

	Value	p-value
Pooled statistic	9.64875	0.00000

Common factors: Cardinality of non-stationary factors (IPR)
Test variant: MQC
Null hypothesis: Retain common factors
Maximum factors: 7 (Schwert)
Factors selected: 7 (Bai and Ng: Average of criteria)
MQ significance level: 5%
Stationary factors: 0

Common trends	Test statistic	p-value
7	3.70216	0.99990

Idiosyncratic elements: Pooled test
Null hypothesis: No cointegration among all cross-sections
Lag selection: AIC with maxlag=7

	Value	p-value
Pooled statistic	1.45552	0.14553

Common factors: Cardinality of non-stationary factors (IND)
Test variant: MQC
Null hypothesis: Retain common factors
Maximum factors: 7 (Schwert)
Factors selected: 7 (Bai and Ng: Average of criteria)
MQ significance level: 5%
Stationary factors: 0

Common trends	Test statistic	p-value
7	3.11926	0.99990

Idiosyncratic elements: Pooled test
Null hypothesis: No cointegration among all cross-sections
Lag selection: AIC with maxlag=7

	Value	p-value
Pooled statistic	2.91679	0.00354

Common factors: Cardinality of non-stationary factors (GIP)
Test variant: MQC
Null hypothesis: Retain common factors
Maximum factors: 7 (Schwert)
Factors selected: 7 (Bai and Ng: Average of criteria)
MQ significance level: 5%
Stationary factors: 0

Common trends	Test statistic	p-value
7	2.81436	0.99990

Idiosyncratic elements: Pooled test
Null hypothesis: No cointegration among all cross-sections
Lag selection: AIC with maxlag=7

	Value	p-value
Pooled statistic	-0.36973	0.71158

Common factors: Cardinality of non-stationary factors
Test variant: MQC
Null hypothesis: Retain common factors
Maximum factors: 7 (Schwert)
Factors selected: 7 (Bai and Ng: Average of criteria)
MQ significance level: 5%
Stationary factors: 0

Common trends	Test statistic	p-value
7	4.51917	0.99990

Idiosyncratic elements: Pooled test
Null hypothesis: No cointegration among all cross-sections

Lag selection: AIC with maxlag=7

	Value	p-value
Pooled statistic	-1.03011	0.30296

Common factors: Cardinality of non-stationary factors
Test variant: MQC
Null hypothesis: Retain common factors
Maximum factors: 7 (Schwert)
Factors selected: 6 (Bai and Ng: Average of criteria)
MQ significance level: 5%
Stationary factors: 0

Common trends	Test statistic	p-value
6	14.08538	0.99990

Idiosyncratic elements: Pooled test
Null hypothesis: No cointegration among all cross-sections
Lag selection: AIC with maxlag=7

	Value	p-value
Pooled statistic	-0.74280	0.45760

Descriptives Data

	IPR	IND	GIP	CO2PC	GHGN	FDI	TOP	POLSTAB	RGDPG
Mean	0.826567	2.856187	8.090308	1.151151	0.373480	2.830541	63.49271	-0.305448	4.481859
Median	0.626506	7.89.6750	1.817206	0.448225	0.313410	2.087350	57.87109	-0.250178	4.693287
Maximum	3.018250	21.33427	63.25339	9.545388	1.675328	24.00908	128.0546	1.223600	15.84367
Minimum	0.126229	0.738646	0.337565	0.056186	0.111729	-10.03838	20.72252	-2.259529	-20.80528
Std. Dev.	0.586672	4.508099	13.63067	1.846157	0.271335	3.383121	24.69560	0.853146	3.665334
Skewness	1.574061	2.194315	2.338802	3.011662	3.163361	1.398574	0.675096	-0.166583	-1.440342
Kurtosis	5.203582	7.131418	7.975302	11.89977	13.38640	9.647110	2.539372	2.246379	11.67113
Jarque-Bera	268.8724	661.4849	849.1202	2102.813	2693.097	946.9808	37.05752	12.36244	1520.157
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002068	0.000000
Sum	361.2096	1248154.	3535.464	503.0529	163.2108	1236.946	27746.31	-133.4810	1958.572
Observations	437	437	437	437	437	437	437	437	437