Financial Development, Economic Growth and Environmental Degradation in Selected Sub-Saharan African Countries

Osaigbovo Britney ISIBOR
PG/MGS/ 0405119

DEPARTMENT OF BANKING AND FINANCE
FACULTY OF MANAGEMENT SCIENCES
UNIVERSITY OF BENIN
BENIN CITY, EDO STATE

FEBRUARY, 2024

Financial Development, Economic Growth and Environmental Degradation in Selected Sub-Saharan African Countries

Osaigbovo Britney ISIBOR
PG/MGS/ 0405119

BEING A DISSERTATION WRITTEN IN THE DEPARTMENT OF BANKING AND FINANCE AND SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY (Ph.D.) IN FINANCE, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA.

FEBRUARY, 2024

DECLARATION

I, Osaigbovo Britney ISIBOR, a Doctor of Philosophy (Ph.D.) candidate of the department of banking and finance, faculty of management science, university of Benin, Benin city, Nigeria, do hereby declare that this dissertation is entirely my work and compositions. The work embodied in this dissertation has not been submitted in candidature for any degree and it is not concurrently being submitted for any other degree. All references from other works have been acknowledged.

…… **……**

Osaigbovo Britney ISIBOR **DATE**
(PG/MGS0405119)

CERTIFICATION OF DESSERTATION

We, certify that this dissertation written by Osaigbovo Britney ISIBOR is adequate in scope and quality in partial fulfillment of the requirement for the award of Doctor of Philosophy (Ph. D) Finances in the Department of Banking and Finance, Faculty of Management Science University of Benin, Benin City, Nigeria.

…… **……**
Prof. G. A. Nwokoye **Date**
(Chief Supervisor)

…… **……**
Dr. O.G. Omorokunwa **Date**
(Co-Supervisor)

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

CERTIFICATION OF DESSERTATION ON ANTI-PLAGIARISM

We the undersigned attest and declare that the dissertation of Osaigbovo Britney ISIBOR titled "Financial Development Economic Growth and Environmental Degradation in Selected Sub-Saharan African Countries" has successfully passed the anti-plagiarism test and does not violate any copyright regulation as at February 1, 2024.

…… **……**
Prof. G. A. Nwokoye **Date**
(Chief Supervisor)

…… **……**
Dr. O.G. Omorokunwa **Date**
(Co-Supervisor)

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

DEDICATION

I dedicate this dissertation to God almighty from whom all knowledge flow and for the rare gift of life, and to the loving memories of my dear father Senior Elder Edward Adun ISIBOR JP.

ACKNOWLEDGEMENTS

First and foremost, I want to thank God Almighty for the gift of life, knowledge and wisdom to undertake this dissertation.

My profound gratitude goes to my supervisors, Prof. G.A. Nwokoye and Dr. O.G. Omorokunwa, for an excellent supervision, I am indebted to you and I want to say, God bless and protect you at all times.

I will not fail to render my gratitude to Prof. I.O. Osamwonyi, Prof. P. O. Eriki, and Prof. D.O. Omoyibo for their mentorship before, during and after this Ph.D. programme.

Posterity will not pardon me if I do not make mention of my darling wife, confidant and soulmate, Mrs. Ruth Osarugue Isibor for the constant encouragement and drive toward completing this work, “iye Osayemwen, mummy Osato, iye Deba baba, I want you to know you occupy a special place in my heart”. Osayemwen, Osatohanmwen and Osadebamwen, daddy love and appreciate you all in equal measures.

To my dear family and siblings, among whom are Mrs. Rose Isibor, Mrs. Dorothy Tunde Ajala, Mr. Ogbemudia, Barr. Osasumwen, Mr. Osazuwa, Mr. Edoba and Mr. Iguodala Isibor, I am most grateful and thankful for your prayers, love and support, I love you all.

To all staffs of the Depart+ment of Banking and Finance amongst whom are Dr. O.G. Omorokunwa, Dr. M.A. Ajao, Dr. U.J. Idolor, Dr. Obayagbona, Dr. Osifo, Dr. Igbinovia, Dr. Osariemen Aigbovo, Dr. Ighodaro, Dr. Orobator and many more too numerous to mention, I appreciate you all for the love and supports.

May I specially mention Dr. Aigbovo Omoruyi for the academic support towards the years gone by and still to come, my boss" I am most grateful".

To the memories of my loving father, Senior Elder Edward Adun Isibor JP., daddy to live in the hearts of those that love you is not to die. I know today would have been your happiest day had it been you were alive, because you have always wanted your children to attain the very zenith of educational qualifications, I am glad these lofty dreams of yours has come to reality today. Continue to rest in Gods bosom till we meet to path no more.

TABLE OF CONTENTS

Title		Page
Title page		i
Declaration		ii
Certification		iii
Certification of Dissertation on Plagiarism		iv
Dedication		v
Acknowledgements		vi
Table of Contents		viii
List of Tables		xii
Abstract		xiv
CHAPTER ONE: INTRODUCTION		
1.1	Background to the Study	1
1.2	Statement of the Research Problem	4
1.3	Research Questions	8
1.4	Objectives of the Study	9
1.5	Hypotheses of the Study	10
1.6	Scope of the Study	11
1.7	Significance of the Study	12
1.8	Limitations of the Study	13
CHAPTER TWO: LITERATURE REVIEW		
2.1	Introduction	14
2.2	Conceptual Review	14

2.2.1 The Concept of Environmental Degradation 14

2.2.2 Indicators of Environmental Degradation 16

2.2.2.1 Carbon Dioxide (CO_2) Emission 16

2.2.2.2 Ecological Footprint 18

2.2.2 Financial Development 20

2.2.3 Indicators of Financial Development 21

2.2.3.1 Credit to Private Sector 22

2.2.3.2 Liquid Liabilities Ratio (Financial Deepening) 23

2.2.2.3 Market Capitalization 24

2.2.2.5 Stock Market Turnover Ratio 24

2.2.4 The Concept of Economic Growth 24

2.2.5 Factors Influencing Environmental Degradation 26

2.2.5.1 Energy Consumption 26

2.2.5.2 Urbanization 27

2.2.5.3 Foreign Direct Investment 27

2.2.6 The Environmental Kuznet Curve 28

2.2.7 The shape of the EKC 31

2.2.8 Overview of Carbon Emissions in Sub-Saharan Africa Countries 36

2.3 Review of Related Theories 37

2.3.1 The Environment Kuznets Curve (EKC) Hypothesis 38

2.3.2 Ecological Modernization Theory 39

2.3.3 Environmental Transition Theory 39

2.3.4 Intergenerational Equity Theory 40

2.3.5 Structural Human Ecological Theory 40
2.3.6 The Compact City Theory 40
2.4 Methodological Review of the Mean Group (MG) and the Pooled Mean Group (PMG) Regression 41
2.5 Empirical Literature 42
2.5.1 Financial Development and Environmental Degradation: Empirical Evidence from Developed Countries 43
2.5.2 Financial Development and Environmental Degradation: Empirical Evidence from Developing Countries 48
2.5.4 Economic Growth and Environmental Degradation: Empirical Evidence from Developing Countries 60
2.6 Summary Table of Reviewed Empirical Literature 70
2.7 Research Gap in the Empirical Literature 88
2.8 Research Conceptual Framework 92
CHAPTER THREE: METHODOLOGY
3.1 Introduction 93
3.2 Research Design 93
3.3 Population and Sample 93
3.4 Sampling Technique and Sample Size 93
3.5 Sources of Data 94
3.6 Theoretical Framework 94
3.7 Model Specification 102
3.8 Measurement of Variables 113

3.9 Data Estimation Techniques 115

CHAPTER FOUR: DATA PRESENTATION AND ANALYSIS OF RESULTS

4.1 Introduction 117

4.2 Data Presentation 118

4.3 Data Analysis 118

4.3.1 Descriptive Statistics 118

4.3.1.1 Trend Analysis 118

4.3 Tests of Time Series and Cross-sectional Properties of the Panel Data 129

4.3.1 Test for Normality 129

4.3.2 Panel Unit Root Test 130

4.3.3 Cross-sectional Dependence Test 132

4.3.4 Bounds Test for Cointegration 133

4.4 Regression Analysis 135

4.4.1 Regression Results for the Effects of Financial Development on Environmental Degradation 135

4.4.2 Test of the Kuznets Hypothesis 142

4.4.3 Causality Between Financial Development and Environmental Degradation 144

4.4.4 The Moderating Role of Financial Development in the Economic Growth and Environmental Degradation Relationship 145

4.5 Robustness Test for Results 148

4.5 Test of Hypotheses 150

4.6 Discussion of Results 153

CHAPTER FIVE: SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1	Summary of Findings	156
5.2	Recommendations	158
5.3	Conclusion	160
5.4	Contributions to Knowledge	160
5.5	Areas of Further Study	161
	References	163
	Appendices	183

LIST OF TABLES

Table 2.1: Tabular Summary of the Empirical Literature Reviewed 70

Table 4.1: Descriptive Statistics for Panel Data 123

Table 4.2: Descriptive Statistics for Individual Countries 125

Table 4.3: Correlation Matrix 127

Table 4.4: Panel Data Unit Root Tests Results in Levels 131

Table 4.5: Panel Data Unit Root Tests Results in First Differences 132

Table 4.6: Cross-section Dependence Test Results 133

Table 4.7: Results of Bounds Test of Cointegration 134

Table 4.8: Short Run PMG Estimates 136

Table 4.9a: Long Run PMG Estimates 138

Table 4.9b: Individual Country Long Run Results 141

Table 4.10: Results for Testing Kuznets Hypothesis 142

Table 4.11: Causality Test Result 144

Table 4.12: Result for the Moderating Role of Financial Development 147

Table 4.13: Post Estimation Test Results – Multicollinearity test 149

ABSTRACT

This study examines the relative effects of financial development and economic growth on environmental degradation in selected Sub-Saharan African (SSA) countries that includes Cote d'ivoire, Ghana, Kenya, Mauritius, Namibia, Nigeria and South Africa. Specifically, the study considered the roles of different financial system development factors on the environment, while also examining the impacts of economic growth on the environment using the environmental Kuznets curve (EKC) formulation. The study also examined the possible direction of causality between environment degradation and both economic growth and financial development among the countries, as well as the influence of financial development on the relationship between economic growth and environmental degradation.

Environmental degradation is measured by the tonnes of carbon emission per country and the rate of ecological footprint which was further divided into per capita footprint on cropland and per capita footprint on built land. Financial system development is measured using both the money and capital markets variables which include credit to the private sector, liquidity in the economy, market capitalization, and stock market turnover. A panel data of seven (7) selected SSA nations for the period of 1990 to 2021 is employed in the analysis, while the Mean Group (MG) and the Pooled Mean Group (PMG) techniques are employed to estimate the long-run and short-run relationship amongst the variables for the panel analysis.

The main finding in the study is that while financial system development and economic growth affect environmental degradation among SSA countries, the effect is more of a long run affair. The short run effects are limited and insignificant in most of the cases. Specifically, financial development is shown to generally increase carbon emission, but reduce ecological footprint (per

capita footprint on crop land and per capita footprint on built land). In particular, the study finds that credit to the private sector and market capitalization is the most important financial market segments that reduce environmental degradation. A strong EKC format was also found to exist among the SSA countries, while the study also found evidence that deeper financial system development will help to manage the impacts of economic growth on environmental degradation among the SSA countries. Adopting responsible financial sector investment as well as deepening the financial markets among SSA countries is therefore the main recommendation in the study. This is intended to ensure that the negative spillover effects of financial and economic development on the environment is limited. The focus of the financial system should be on sustainability and ensuring that instruments in the system are environmentally responsible.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Achieving economic growth and preserving the earth's environment are the two major challenges confronting the world in the 21st century. Environmental degradation has appeared to the forefront of contemporary issues for all countries mainly as a consequence of increase in emissions of atmospheric greenhouse gases (GHGs) which have caused changes to climate, and as a result, pose a major challenge confronting humans in the 21st century (Olubusoye & Dasuki, 2020). Among the greenhouse gases, Carbon Dioxide (CO_2) is the most dominant gas in the atmosphere and it plays a powerful role in enhancing the greenhouse effect and is responsible for over 60 percent of this effect (Acaravci & Ozturk, 2010).

In the fourth assessment report of international panel on climate change (IPCC's), increase in the carbon emission intensity per unit of gross domestic has been reported which indicates that global CO_2 emissions are increasing at a higher rate since 1970's. These have caused changes to climate and global warming, and as a result policy makers find it increasingly difficult to manage the trade-off between economic growth and environmental protection (Bacon & Bhattacharya, 2007; IPPC, 2014; Majeed & Mazhar, 2019). The realization of sustainable growth has become the fundamental objective of all economies. The role of financial sector is fundamental to accomplish sustainable growth and development. However, governments have understood that the financial system needs to become sustainable in the long-run and that the transition to a low-carbon and green economy may facilitate this change. To reach this pathway, it is necessary to realign the financial system with the sustainable development goals (SDGs) (Majeed, 2018).

Green financing, in this sense, is centred on a new financial architecture that supports both environmental preservation and growth/development. It is predicated on the notion of "green credit," which financial institutions employ to mitigate environmental strain by funding environmentally friendly investments and energy-efficient technologies. Another tool for reducing environmental pollution is interest rates, which may be used to fund clean technology adoption by enterprises at low interest rates. Financial institutions also support research and development (R&D) in the field of new energy resources, with a particular focus on ecological agriculture (Xu, 2013).

Environmental degradation (the emissions of greenhouse gases (GHGs) particularly, carbon dioxide) have been identified to constitute a greater share of the causes of global warming and climate change. To tackle the problem of climate change, it has been argued that there is the need to reduce the emission of GHGs otherwise long-run economic growth and national security will be adversely affected (The White House, 2016). To that end, discussions and ensuing empirical research have been carried out regarding the relationship between financial development and environmental deterioration, as well as the relationship between economic activity (growth/development) and environmental deterioration.

There exist two divergent perspectives in the literature about the nexus between environmental degradation and financial progress. On one hand, financial development promotes technological innovation which helps to reduce environmental degradation (Sadorsky, 2011; Chang, 2015). Further, Tamazian, Chousa & Vadlamannati, (2009); Shahbaz, Khan, & Tahir (2013) have argued that financial development may improve environmental quality when firms are encouraged by their financiers (that is, financial institutions) to invest in eco-friendly technology which reduces CO_2 emissions. Contrary to the above views is the idea that financial development

may increase emission of carbon dioxide by increasing energy consumption for economic activities. This is because financial development allows individuals and firms to obtain capital which enables them afford energy consumption appliance thereby increasing environmental degradation (carbon emissions) (Mahalik & Mallick, 2014; Chang, 2015).

In the context of the link between economic growth and environmental degradation 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 nature. At the start or earliest stage of development, Green House Gas emissions (environmental degradation) increases but after reaching certain point (turning point), emissions 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).

Global attempts to mitigate carbon emissions, which translate to lessening environmental harm, are becoming more widespread. All nations, including those in Sub-Saharan Africa, are parties to the United Nations Framework Convention on Climate Change (UNFCCC), which was established to stabilise the concentration of greenhouse gases in the atmosphere. Parties to the UNFCCC have agreed to keep global warming to 2 degrees Celsius (3.6 f) over pre-industrial levels. The trend of GHG emissions, however, indicates that there may be some discrepancies that jeopardise the attempts to keep global warming to 1.5 or 2 degrees. This objective will be jeopardized if GHGs fail to fall by 7.6% per year between 2020 and 2030 (United Nations Department of Economic and Social Affairs Population Division, 2019). Thus, Sub-Saharan

Africa (SSA) has a significant opportunity to contribute to international initiatives aimed at reducing carbon emissions and the effects of climate change in the future.

Hence, this study examines how financial development (credit to private sector, liquid liabilities ratio, market capitalization to gross domestic product, stock market turnover ratio) and economic growth affect environmental degradation in selected Sub-Saharan Africa countries.

1.2 Statement of the Research Problem

There are contradictory results in the empirical literature about the relationship between environmental degradation and financial development, as well as between environmental degradation and economic growth. While a positive significant relationship was reported in several studies, negative significant or no significant relationship appeared in others. Hence, the results are mixed and inconclusive. For instance, researchers such as Tamazian et al., (2009); Mahalik & Mallick, (2014); Sehrawat, Giri & Mohapatra (2015); and Gill, Hassan & Haseeb, (2019) among others, have investigated the relationship between financial development and environmental degradation. They concluded that financial development reduces environmental degradation. On the other hand, the studies of Al-Mulali, Saboori & Ozturk, (2015); Shahbaz, Shahza, Ahmad & Alam, 2016; Aslan, Destek & Okumus, (2018); Le, Le & Taghizadeh-Hesary, 2020 have found that the financial development increases environmental degradation.

The findings of earlier research are likewise conflicting with regard to the connection between environmental deterioration and economic growth. Some studies confirmed the EKC hypothesis with an inverted U-shaped relationship between economic growth and environmental degradation (Shahbaz, Lean & Shabbir, 2012; Tiwari, Shahbaz & Adnan-Hye 2013; Alam, Murad & Nomanc, 2016; Al-Mulali & Ozturk, 2016; Kwakwa & Adu, 2016; Sinha & Sen,

2016; Aboagye, 2017; Boopen & Vinesh, 2011; Shahbaz, Ferrer & Shahzad, 2018; Sinha & Shahbaz, 2018; Dong, Sun & Li 2018). In contrast, other studies reported non-existence of EKC, arguing that increase economic growth reduces environmental quality (Nassani, Aldakhil & Abro, 2017; Dogan & Ozturk, 2017; Pal & Mitra, 2017; Sinha, Shahbaz & Balsalobre – Lorente, 2017; Balsalobre-Lorente, Shahbaz, Roubaud & Farhani, 2018; Onafowora & Owoye, 2014).

The mixed results could be attributed to the heterogonous financial structure of the studied countries; methodological flaws and omitted variables bias could also be the reason for the conflicting results; divergent climate condition and pattern of carbon emissions of the country or countries under investigation could also account for the mixed results; the reasons for the variations in results might possibly be related to the data utilised and the variations in some parameters defining the nations under study. 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 environmental consequences of improved financial system and economic growth in the context of Sub-Saharan Africa.

Furthermore, unlike majority of the previous studies (Bekhet, Matar & Yasmin, 2017; Maji, Habibullah, & Saari, 2017; Zakaria & Bibi, 2019 among others), this study utilized both carbon dioxide (CO_2) emission and ecological footprint as a measure or indicator of environmental degradation. A significant shortcoming of much prior research on this topic especially that conducted in Sub-Saharan African nations is that it uses CO_2 emissions as the sole measure of environmental deterioration. However, CO_2 emissions are not a comprehensive indicator of environmental degradation. However, according to Al-Mulali et al. (2015), CO_2 emissions are only one facet of the environmental damage brought on by extensive energy use. This research is

one of the few in Sub-Saharan Africa that uses both CO_2 emission and ecological footprint measurements to investigate how financial development and economic expansion affect environmental deterioration. Employing ecological footprint as an additional measure of the environment, gives a better knowledge of environmental deterioration since it is a more complete measure and trustworthy indication of environmental degradation and will no doubt make the results more robust and provide a strong basis for comparative analysis between the two measures, which improves the robustness.

Also, another key issue with most of the previous studies is the estimation technique utilized for the panel data analysis. Thus, studies employing estimation techniques like Random or Fixed effect methods are confronted with the problem of parameter heterogeneity which can produce inconsistent and potentially very misleading estimates of the average values of the parameters in panel data models. The Mean Group (MG) and the Pooled Mean Group (PMG) method developed by Pesaran,Shin, & Smith (1999) is appropriate for this study as it allows for a higher degree of parameter heterogeneity in regressions than the other estimators.

The PMG estimator provides a way of at least partly overcoming the problem of parameter heterogeneity by assuming homogeneity of the long run coefficients while allowing the short run coefficients and error variances to differ across countries. Hence, the PMG estimator considers country-specific effects as usual but also allows the short run growth responses of each country to vary, imposing only common long run relationships. The MG estimator allows for heterogeneity of all coefficients, intercepts and slopes, by estimating a separate equation for each country while the coefficients for the whole panel are computed as un-weighted averages of the individual coefficients. Hence, 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 financial development and economic growth on environmental degradation in Sub-Saharan African countries.

A number of studies have been carried out to analyse the effect of financial development on environmental degradation (Ozturk & Acaravci, 2010; Ziaei, 2015; Majeed & Mazhar, 2019 Shogbande & Ogbeifun, 2021 among others) as well as effect of economic growth on environmental degradation (Narayan & Narayan, 2010; Al-Mulali & Ozturk, 2016; Sinha & Sen, 2016; Emir & Bekun, 2019; Olubusoye & Dasuki, 2020 among others), it was observed from the survey of extant literature that few studies (Tamazia et al., 2009; Kwakwa, Alhassan & Aboagye, 2018) have examine the joint influence of financial development and economic growth on environmental degradation. The joint effect of financial development and economic growth on environmental degradation is largely unexplored in Sub-Sahara African context. Hence, this study will develop a model that accounts for the joint effect of financial development and economic growth on environmental degradation in sub-Saharan Africa countries.

Also, majority of existing literature investigating the EKC hypothesis utilised the polynomial regression models. The polynomial specification contains as independent variables such as GDP, the square of GDP and in some cases, GDP raise to the third degree which enables detection of linear, quadratic and cubic relationships respectively (Gao & Zhang, 2014; Alege, Adeyemi & Ogundipe, 2016; Ketenci, 2018; Egbetokun, Osabuohien, Akinbobola, Onanuga, Gershon & Okafor, 2019 among others). High multi-collinearity among the variables has been identified to accommodate this approach, which will lead to spurious results, thus, inferences drawn from spurious results will be misleading in policy making with great implications. The present study will fill the gap, by using a non-polynomial model to investigate the presence of an inverted U

relationship also known as the environmental Kuznets curve (EKC) in selected sub-Saharan Africa countries.

The criteria to investigate the presence of EKC using a non-polynomial model proposed by Narayan & Narayan (2010) is that when the long-run income elasticity (GDP) is less than the short-run income elasticity then the relationship is consistent with the EKC hypothesis. Otherwise, if the short-run income elasticity is positive and statistically significant and the long-run income elasticity is negative and statistically significant, then it suggests the presence of EKC, which implies that environmental degradation (carbon emissions) have increased and reduced over time as income in the country increases.

The motivation for this study is hinged on the need to fill these gaps in knowledge. This has become paramount in view of the undesirable consequences of environmental degradation (the emission of GHGs).

1.3 Research Questions

Based on the foregoing, the overriding research question for this study will be; what is the effect of financial development and economic growth on environmental deterioration in selected Sub-Saharan African countries? Specifically, the study seeks to offer answers to the research questions below:

(i) To what extent does credit to private sector affect environmental degradation in selected Sub-Saharan African countries?

(ii) To what degree does broad money supply to gross domestic product affect environmental degradation in selected Sub-Saharan African countries?

(iii) To what extent does market capitalization to gross domestic product affect environmental degradation in selected Sub-Saharan African countries?

(iv) What is the effect of stock market turnover ratio on environmental degradation in selected Sub-Saharan African countries?

(v) Does the environmental Kuznets curve hypothesis (EKC) exist in the selected Sub-Saharan African countries?

(vi) What is the direction of causation between financial system development and environmental degradation and as well as between economic growth and environmental degradation in selected Sub-Saharan African countries?

(vii) What is the influence of financial development on the relationship between economic growth and environmental degradation in selected Sub-Saharan African countries?

1.4 Objectives of the Study

The general objective of this study is to empirically investigate the effect of financial development and economic growth on environmental degradation in selected Sub-Saharan African countries. The particular objectives include to;

(i) determine the effect of credit to private sector on environmental degradation in the selected Sub-Saharan African countries;

(ii) ascertain the extent to which broad money supply to gross domestic product affect environmental degradation in the selected Sub-Saharan African countries;

(iii) determine the extent to which market capitalization to gross domestic product affect environmental degradation in selected Sub-Saharan African countries;

(iv) investigate the effect of stock market turnover ratio on environmental degradation in selected Sub-Saharan African countries;

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

(vi) determine the direction of causation between financial system development and environmental degradation as well as between economic growth and environmental degradation in the selected Sub-Saharan African countries; and

(vii) examine the influence of financial development on the relationship between economic growth and environmental degradation in selected Sub-Saharan African countries.

1.5 Hypotheses of the Study

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

$H0_1$: Credit to private sector has no significant effect on environmental degradation in selected Sub-Saharan African countries.

$H0_2$: Broad money supply to gross domestic product has no significant effect on environmental degradation in selected Sub-Saharan African countries.

$H0_3$: Market capitalization to gross domestic product has no significant effect on environmental degradation in selected Sub-Saharan African countries.

$H0_4$: Stock market turnover ratio has no significant effect on environmental degradation in selected Sub-Saharan African countries.

$H0_5$: The environmental Kuznets curve hypothesis (EKC) does not exist in the selected Sub-Saharan African countries.

$H0_6$: Financial system development does not Granger-cause environmental degradation; economic growth does not Ganger-Cause environmental degradation in the selected Sub-Saharan African countries or Environmental degradation does not Granger-cause financial system development; environmental degradation does not Granger-cause economic growth in the selected Sub-Saharan African countries.

$H0_7$: Financial development does not influence the relationship between economic growth and environmental degradation in selected Sub-Saharan African countries

1.6 Scope of the Study

The study is a cross country study of the effect of financial development and economic growth on environmental degradation of seven (7) selected Sub-Saharan African countries (Cote d'ivoire, Ghana, Kenya, Mauritius, Namibia, Nigeria and South Africa). The choice of the countries was based on the fact that the seven (7) countries selected in Sub-Saharan African are considered to be one of the most developed countries in their respective region with availability of data that cover the same period. On this basis, the sample size of seven (7) countries was selected. The study covers a period of thirty two (32) years (1990 to 2021). The choice of this period was to ascertain the current trend of financial development and economic growth on environmental degradation of selected Sub-Saharan African countries. Similarly, the period is somewhat relevant since most of the financial reforms were introduced in the mid-1980s and most of the extant literature did not focus on how financial development and economic growth affect environmental degradation in Sub-Saharan African countries. More so, the study extended the time frame from 1990 to 2021 as the time frame of most of the previous studies on the subject matter is not current as at today. The most current study (Habiba & Xinbang, 2022) used a time

frame of nineteen years (2000 - 2018) and employ only bank based financial development indicators, without giving attention to the stock market based financial development indicators.

1.7 Significance of the Study

The influence of financial development as well as the growth of economy on environmental degradation has remained a debated 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 environmental consequences of improved financial system and economic growth in the context of Sub-Saharan Africa. This research will contribute to the extant literature by using recent data to explore the effect of financial development and economic growth on environmental deterioration in selected Sub-Saharan African countries thus adding new evidence to the financial development-environmental degradation debate as well as the economic growth-environmental degradation debate.

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

Government/Policy makers and Regulators: By indicating which non-limiting factors of CO_2 emissions should be taken into consideration as area(s) of interest for each of the selected SSA countries in the further integration of their respective climate change and green economy strategies and policies into their development plans, the study's findings will provide policymakers with a useful platform. Also, the outcome of this research can provide guidelines for policymakers and regulators to form a good environmental degradation control policy – especially, the climate change adaptation and other environmentally related policies.

Banks and other financial institutions: The management of banks, which frequently provides the funding for the discovery and exploitation of natural resources, which results in increased emissions into the atmosphere, would also benefit from this study.

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 study without limitation, especially with regards to the methodology that will be adopted. Although the Mean Group (MG) and the Pooled Mean Group (PMG) method developed by Pesaran, Shin, & Smith (1999) is the most appropriate technique for this study as it allows for a higher degree of parameter heterogeneity in regressions than the other estimators, however it has its own shortcoming. 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 & 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. Another limitation envisaged for this study will be the disparity in the sizes of the countries included in the sample size as well as their varying degrees of financial development. However, in order to mitigate this limitation, the study will employ relevant statistical and econometric techniques and procedures such as the MG and PMG designed to minimize the effect of such disparities.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter comprehensively reviews a wide range of literature that relates to financial development, economic growth and environmental degradation. This chapter covers review of conceptual literature, theoretical literature, methodological and empirical studies. A table that summarizes the reviewed empirical literature is also provided as well as research gaps and conceptual framework.

2.2 Conceptual Review

This section presents the meanings of the dependent variable (environmental degradation) and the independent variables: financial development (credit to private sector, broad money supply, market capitalization, and stock market turnover ratio) and economic growth. The section also presents the concept of environmental Kuznet curve, the shape of the EKC as well as overview of carbon emission in Sub-Saharan Africa countries.

2.2.1 The Concept of Environmental Degradation

Environmental degradation is a very serious problem worldwide which covers a variety of issues including pollution, biodiversity loss, and animal extinction, deforestation and desertification, global warming, and a lot more (Brown, Hanson, Liverman & Merideth, 1987; Tian, Zhou, Jiang, Ren & Qiu, 2004). However, the common forms of environmental degradation include desertification, land degradation, rising sea levels induced by global warming, and deforestation with its many consequences (Astri, 1993). Environmental

degradation is the deterioration of the environment through depletion of resources such as quality of air, water and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable (Johnson, Ambrose, Bassett, Bowen, Crummey, Isaacson, Johnson, Lamb, Saul & Winter-Nelson, 1997). Environmental degradation is deterioration of the environmental through depletion of resources which includes all the biotic and abiotic element that form our surrounding that is air, water, soil, plant, animals, and all other living and non-living element of the planet of earth (Malcolm & Pitelka, 2000; Bourque, Cox, Allen, Arp & Meng, 2005; Maurya, Ali, Ahmad, Zhou, da Silva Castro, Khane & Ali, 2020).

Environmental degradation refers to the deterioration of the environment through the depletion of resources, the destruction of ecosystems and the extinction of wildlife (Trimurthyvishal, 2010) as well as reducing biological diversity and the general health of the environment (Mary, 2015). Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems and the extinction of wildlife. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable (Aduebe, 2013). Environmental degradation is the disintegration of the earth or deterioration of the environment through consumption of assets, like, air, water and soil. It also includes the destruction of environments and the eradication of wildlife (Chopra, 2016). Environmental degradation is the result of a variety of human actions that have resulted in a decline in environmental quality due to natural resource depletion, species expansion, weather fluctuations, and ecosystem loss (Majeed & Mazhar, 2019). Conserve Energy Future (2020) defines environmental degradation as the disintegration of the earth or deterioration of the

environment through the consumption of assets, for example, air, water and soil; the destruction of environments and the eradication of wildlife. It is characterized as any change or aggravation to nature's turf seen to be pernicious or undesirable.

According to the 5th IPCC assessment, most climate scientists agree that the main cause of the current global warming trend is the human expansion of the "greenhouse effect". Over the last century the burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO_2). This is so because the coal or oil burning process combines carbon with oxygen in the air to make carbon (Gasser & Luderer, 2018, IPCC, 2018). To a lesser extent, respiration, the clearing of land for agriculture, industry, and other human activities have increased concentrations of greenhouse gases.

Thus, the major causes of the environmental degradation are modern urbanization, industrialization, over-population growth, deforestation etc. There are various adverse effects of environmental degradation. These effects include: Impact on human health, loss of biodiversity, and ozone layer depletion. Global warming is another result of environmental degradation (Chopra, 2016).

2.2.2 Indicators of Environmental Degradation

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

2.2.2.1 Carbon Dioxide (CO_2) Emission: 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 (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.

A 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 these 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).

2.2.2.2 Ecological Footprint: The Ecological Footprint framework addresses climate change in a comprehensive way beyond measuring carbon emissions. It shows how carbon emissions compare and compete with other human demands on our planet, such as food, fibers, timber, and land for dwellings and roads. However, carbon emissions are only one aspect of the environmental damage produced by large-scale energy usage (Al-Mulali & Sheau-Ting, 2014). The ecological footprint is a newer field of study of environmental impacts. The ecological

footprint is a measure of human demands by the Earth's ecosystems. From this concept, many other concepts, such as carbon footprint, water footprint and land footprint were developed (Jović, Laković, & Jovčevski, 2018).

By recording the area of biologically productive land and sea needed to produce the renewable resources this population consumes and assimilate the waste it generates, using current technology, ecological footprint accounts serve as balance sheets for a given population, be it a household, district, city, region, or all of humanity. It records the degree to which human economies are able to replenish themselves within the environment. Overall, it is the sum of built-up land, carbon, cropland, fishing grounds, forest products and grazing land (Majeed & Mazhar, 2019).

Using ecological footprint has the benefit of stressing how much of the ecosystem surface humans utilise for survival by combining environmental data into a single metric that is simple to compare to the corresponding productive capacity. As the world's population rises, so does the demand for natural resources. As a result, securing the long-term use of natural resources has turned into a worldwide concern. As a result, knowing the degree of natural resource usage is critical in order to protect them for future generations. Many studies consider the ecological footprint to be a more complete and trustworthy indication of environmental impact (Al-Mulali & Sheau-Ting, 2014; Uddin, Salahuddin, Alam, & Gow, 2017). Ecological footprint is measured in global hectares (GHA) per person (Charfeddine & Mrabet, 2017; Katircioglu et al., 2018). It is anticipated to show the natural resource consumption and the productive capacity of the ecosystem (Aydin et al., 2019). Ecological footprint will be measured as per capita footprint on cropland and per capita footprint on built land.

2.2.2 Financial Development

The financial system means body of rules and regulations and the aggregation of financial arrangements, institutions of the world that foster economic growth and development of a nation (CBN, 1993). The financial sector is the set of institutions, instruments, markets, and the legal and regulatory framework that permit transactions to be made by extending credit (World Bank, 2016). Financial systems perform the key functions of mobilizing savings, allocating capital, providing an efficient payment system, monitoring and exerting corporate governance, as well as ameliorating risk (Aziakpono, 2008; Starkey, 2010). A major determinant of the ability of a financial system to effectively and efficiently perform these key functions is the extent to which a country's financial system is developed. The size, structure and efficiency of a financial system determine its development.

Levine (2004) posits that the development of financial system occurs when financial instruments, financial markets and financial intermediaries, reduce the costs of executing contracts and the costs of transaction. Nwanyanwu (2011) defines financial system development as the increased financial services in an economy with a wider choice of services geared to all level of society. Financial system development is generally defined as the improvement in quantity, quality and efficiency of the financial system services Aigbovo, (2013). Financial development occurs when financial instruments markets and intermediaries ease the effect of information, enforcement, and transaction costs and do a correspondingly better job at providing the critical functions of the financial sector in the economy (World Bank, 2016).

Scholars have argued that financial development could have a critical effect on the quality of the environment, especially on the evolution of carbon emissions. However, the evidence is a priori

uncertain about having either a positive, negative, or neutral impact on environmental degradation. This implies that for financial development, the expectation is either a positive or negative estimated parameter. This is because while financial development can be detrimental to environmental quality, it can also be advantageous. Financial development helps producers buy advanced machinery and equipment by offering cheaper loans, reducing environmental degradation. Additionally, financial development could also increase environment-friendly investments by promoting renewable energy sources and efficient technologies and lead to environmental quality (Shahbaz, Shahzad, Ahmad & Alam 2016). On the other hand, financial development provokes customers to borrow money and buy luxurious products like houses, automobiles, and air conditioners, resulting in environmental pollution (Baloch, Zhang, Iqbal & Iqbal, 2018).

Funds for environmentally friendly and energy-saving initiatives are made possible by a well-developed financial institution. Additionally, financial institutions offer incentives to businesses that use energy-efficient equipment, which lowers operating costs and enhances environmental quality. Furthermore, by drawing in more foreign direct investment (FDI), which raises productivity, R&D, and investment in green technology, it may help enhance the quality of the environment (Hamdan et al. 2018). As a result, a solid financial institution and partnership between banks and capital markets offers a hopeful route to better environmental quality.

2.2.3 Indicators of Financial Development

The indicators of financial system development are variables that reveal the size, structure and efficiency of the financial system. To measure the effects of financial system development on environmental degradation requires variables that reveal the activities or performance of the

financial system. Note that there exists no unique set of variables across studies, for analyzing the influence of financial sector development on environmental degradation. Different studies have employed a wide range of indicators of financial sector development. Based on existing literature on various indicators of financial sector development (Levine, Lin, and Chu 2000), this study focuses on two groups of financial sector development indicators. The two groups of financial development measures include: banking system development (BD) measures, and stock market development (SD) measures. These BD measures include the credit to private sector and liquid liabilities ratio while the two SD measures include the market capitalization and the turnover ratio.

2.2.3.1 Credit to Private Sector: Private sector credit ratios to GDP are the most comprehensive gauge of the activity of banks and it is calculated as the amount of domestic credit allocated to the private sector (by the banking sector) divided by GDP. It indicates the extent to which banks fund the economy, and more precisely the degree to which banks fund private investment and private sector development (World Bank, 2009).

This ratio not only specifies banking system size but also significance of the banking sector to private sector of an economy. Domestic credit provided by the private sector comprises financial resources which create a claim for paying back such as credits, procurements of non-equity securities, trade credits and other accounts receivables (World Bank, 2009). Hence, credit given to governments and public enterprises are not regarded as domestic private credit (Beck & Levine, 2004). According to Beck, Dermigue-Kunt, & Levine (2000), the ratio of credit to private sector relative to GDP is a measure of the relative size of the banking system to the size of the economy.

This measure of banking sector development is critical for poverty reduction and for financing consumption, production and capital formation, which helps to stimulate aggregate demand and, in turn, advance economic activity (World Bank, 2008). This indicator according to Beck, Levin, and Loayza (2000) is superior to other measures of financial intermediaries' development because it excludes credit to public sector and better reflects the level of efficient allocation of resources. Domestic credit to private sector talks about financial assets provided to private sector by financial institutions, such as through loans, procurements of non-equity securities, and trade credits and other accounts receivable, that institute a claim for repayment.

The effect of credit to private sector on environmental degradation may be positive or negative, depending on how the domestic credit provided to the private sector is utilized. The private sector may either invest in energy efficient technology and mode of production, and this will help to improve environmental quality or they may just choose any method of production which might be injurious to the environment.

2.2.3.2 Liquid Liabilities Ratio (Financial Deepening): This is utilized as an indicator of the size of the banking system, taken as the size of the financial intermediaries relative to the size of the economy. It is otherwise known as measure of financial deepening. The ratio measures the degree of monetization in the economy as well as the depth of the banking sector while it also shows an expansion of payment and savings functions. This measure provides an indication of the banking system's ability to increase lending (World Bank, 2009). The liquid liabilities ratio is calculated as M2-broad money supply (currency plus demand and interest-bearing liabilities of bank and non-bank financial intermediaries) divided by GDP.

2.2.2.3 Market Capitalization: This is computed as stock market capitalization (share price multiplied by total number of shares outstanding) divided by GDP. The ratio is used as a measure of stock market size. The idea of the indicator is that the larger the market size, the higher the ability to mobilize capital and diversify risk (N'zue, 2006). Market capitalization takes into account the current market price, which reflects the current value and the total number of shares which reflects the size of a company and gives a clear picture of the market value of a company. Okikii and Nzomoi (2013) define market capitalization as the combined value of all company's outstanding shares listed in a national stock exchange. In the opinion of Omodero (2020) market capitalization is the total monetary value of all outstanding shares of a company. It is calculated by multiplying the current share price by the number of outstanding shares. Thus, market capitalization is a function of share price. Therefore, it can vary greatly from month to month or even from day to day (Maverick, 2019).

2.2.2.5 Stock Market Turnover Ratio: This is the amount of securities traded divided by the market capitalization. It measure how active a market is. It also indicates the trading volume of the stock market relative to size. The turnover ratio measures the value of equity transactions relative to the size of the equity market, and is an indicator of the efficiency of the financial intermediation (Adegbite, 2008).

2.2.4 The Concept of Economic Growth

Simon Kuznets (in Todaro, 1985: 114) defined a country's economic growth as "a long-term rise in the capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional and ideological adjustments that it demands". Burda and Whyplozs, (2005) define economic growth as the increase (or growth) of a

specific measure such as real national income, gross domestic product, per capita income or other measures of aggregate income. 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. Olowofeso, Adeleke & 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.

Environmental deterioration is thought to be mostly determined by economic growth. There are three ways in which environmental quality can be impacted by economic expansion. First, when input use rises for increased output, the environment deteriorates more (scaling impact). Second, environmental deterioration develops initially with the composite change of growth path from agricultural to the industrial sector and then reduces in the latter stage with the expansion of the service sector (composite impact). Lastly, technological advancement helps to curb the pollutant emissions by introducing the green technology (technique effect) (Stern, 1998; Stokey, 1998). Regarding its linear effect it is identified that expansion in economic growth causes the development in the major economic sectors such as agriculture, industrial and services sectors that in turn leads to higher investment, and consumption, thereby reducing the environmental quality (Bloach, Zhang & Iqbal, 2019).

The important measure of economic growth is gross domestic product which measures the monetary value of goods and services that are produced in the economy during a fiscal year. Other possible measures include total factor productivity, factors of production such as technological change, human capital termed the Schumpeterian approach. Other measure of

growth ranges from real per capita GDP; the rate of physical capital accumulation etc, (King & Levine 1993). In this study, economic growth will be measured as Gross domestic product per capita.

2.2.5 Factors Influencing Environmental Degradation

In the extant literature, several determinants of environmental degradation have been highlighted. The most widely identified determinants of environmental degradation are income, industrialization, international trade, urbanization, deforestation, population, energy consumption, etc. The determinants of environmental degradation utilized as control variables in this study include energy consumption, urbanization and foreign direct investment.

2.2.5.1 Energy Consumption: It describes the utilisation of basic energy prior to its conversion into other end-use fuels, which is equivalent to domestic production plus imports, stock adjustments, and exports less fuel given to planes and ships involved in international transportation. Its impact on environmental deterioration is contingent upon the manner, means, and intent of its use. If energy is efficiently utilized in green technologies then it will help to reduce the harmful environmental effects (Stern, Bakhshi, Bowen, Cameron & Catovsky, 2006). While the higher amount of energy consumption in terms of higher demand for gas, oil and coal contributes to the pollutant emissions along with the resource degradation that deteriorates the overall environment (Mirza & Kanwal, 2017).

Energy's combustion processes discharge greenhouse gases (GHGs) into the atmosphere, including carbon dioxide, sulphur dioxide, and nitrogen oxides, which have an adverse influence on the environment. Given this, any inefficiencies in energy use will exacerbate environmental

deterioration. On the other hand, efficiency in energy usage will help reduce environmental degradation via carbon dioxide emission (Sharma, 2011; Kwakwa & Adu, 2016).

2.2.5.2 Urbanization: It alludes to those who reside in cities. Wang, Zeng, and Wu (2016) opined that that urbanization increases the environmental degradation by increasing the energy and resource demand and their consumption. However, it can improve the environmental quality for the high-income economies (Chikaraishi, Fujiwara, Kaneko, Poumanyvong, Komatsy & Kalugin, 2015). Additionally, it boosts economies of scale and facilitates the effective utilisation of transportation and space. It also increases the productivity and boosts the green technology over the longer period that reduces the resource inefficiency and improves the environmental quality (Arouri, Shahbaz, Onchang, Islam & Teulon, 2013; Majeed & Gillani, 2017). As urbanization increases, economic activities expand, and pollution increases too. Urbanization is an essential factor influencing environmental degradation. This variable can have a positive or negative impact. Urbanization is measured as the urban population as a percentage of total population.

2.2.5.3 Foreign Direct Investment: These are the net inflows of capital obtained through the purchase of a long-term management stake in a business that operates in an economy different from the investor's. It is represented by the balance of payments and is the total of equity capital, earnings reinvested, other long-term capital, and short-term capital. Foreign enterprises use cleaner technologies following the environmental protection laws and promote R&D in the energy-efficient technology, thereby leading to higher environmental quality (Zarsky, 1999; Asghari, 2013). The rise in foreign direct investment in response to a more developed financial system can also contribute to environmental degradation because the inflow often goes directly into resource extraction, infrastructure, and manufacturing operations (Mabey & McNally, 2019).

If the foreign companies come along with advanced and environmental friendly technology, carbon emissions will reduce; otherwise emissions will go up, especially if the host country government does not mandate foreign companies to use low carbon emitting methods of production and technology. If carbon emissions and all other forms of pollution rise due to increased FDI, then it means the pollution haven hypothesis is applicable to the host country.

The pollution haven theory, which contends that FDI raises investment in highly polluting industries and degrades environmental quality is the name given to the indirect relationship between FDI and environmental deterioration. FDI can also lead to a rise in air pollution and greenhouse gas emissions in countries with inadequate infrastructure, a weak institutional framework, and lax environmental protection legislation (Solarin, Al-Mulali, Gan & Shahbaz, 2018). The measurement of FDI as a significant factor in environmental deterioration is FDI inflows as a proportion of GDP.

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.

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.

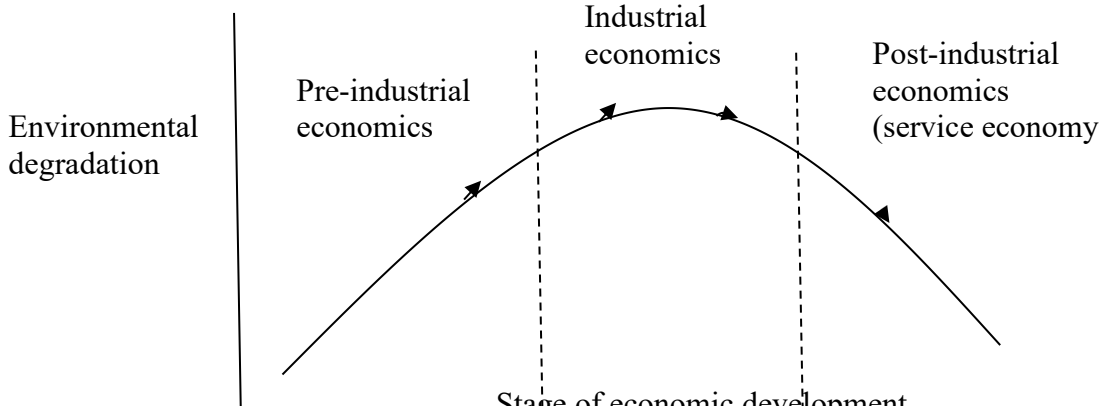


Figure 2.1: The shape of the EKC

Notes: The horizontal axis is income per capita.
Source: Panayotou (2003:46)

The fact that the environment is a luxury commodity has an income influence on the behaviour of the EKC. Environmental quality degrades early in the economic growth process because people are hesitant to exchange consumption for investments in environmental preservation. People start to expect larger investments in better environments after they reach a certain level of consumption (or wealth). As a result, environmental indices show declines in pollution and deterioration following the tipping point (Moomaw & Unruh, 1997; Galeotti, 2003).

Growth provides an additional explanation for the geometry of EKC. Richer economies tend to have more educated citizens who have fewer children, which slows down population growth. Because of the slower rate of population expansion, there is less demand on natural resources, which results in less environmental deterioration. The idea that early growth typically results in low environmental quality may also be used to explain the form of the EKC. Developing nations, particularly the poorest ones, lack the resources and means to embrace clean technology. However, as countries get richer and adopt clean technologies, environmental quality improves (UNCTAD, 2012).

From an optimistic point of view, the EKC hypothesis suggests that economic growth is, by itself, the solution to environmental problems in the sense that environmental improvement is almost

an inevitable consequence of economic growth, and thus, when a country becomes richer, current environmental problems will be addressed by policy changes that not only protect the environment, but also promote economic development (Roca et al., 2001; Perman & Stern, 2003). However, this is a very simplistic conclusion, since environmental degradation is not explained solely by the current emissions rates or pollutant concentrations, but also depends on past environmental pressures, and as Arrow et al. (1995) conclude, "economic growth is not a panacea for environmental quality; indeed is not even the main issue".

2.2.7 The shape of the EKC

The traditional EKC (as illustrated in Figure 2.1) has been criticised by many, both as a prescription for policy and as a depiction of what really occurs in the development process. Some politicians in developing nations have read the EKC as sending a message about priorities: 'grow first then clean up later'. That is, in the first stage of industrialization people are more interested in jobs and income than clean air and water (Dasgupta et al., 2002). However, the supposition that the rich care more about the environment than the poor (Martinez-Alier, 1995) is systematically evidentially far from conclusive (Kriström & Riera, 1996). This implies that policymakers might be able to prevent environmental degradation at any stage of development (Neumayer, 2002).

Because public and global concern about environmental quality is rising, it is highly possible that emerging countries will be able to improve their environmental quality by regularly punishing harmful polluters, even in the absence of official regulations. A lower and flatter EKC than what the traditional EKC predicts may then be experienced by some countries. That is, they may be able to develop from low-income per capita with little degradation in environmental quality and

at some point experience improvements in both income and environmental quality (Dasgupta *et al*., 2002). This reasoning has led to the suggestion that the form of the EKC is unlikely to be fixed in future study.

As a result, the EKC comes in three different flavours: the traditional EKC, the generalised EKC, and the updated EKC (which is anticipated to be flatter). According to recent data, the EKC model is false because it makes the erroneous assumption that emerging nations lack effective environmental regulation. The new results suggest that the curve is actually flat and shifts to the left, as growth generates less pollution in the early stages of industrialization and pollution begins to fall at lower income levels (Dasgupta *et al*., 2004). This is seen in Figure 2.2, where pollution declines at a lower income level on the revised EKC compared to the traditional EKC and the conventional EKC is still growing at the point when the revised EKC is at its maximum. The flatter EKC proposed by UNCTAD (2012) (explained in the previous section) and the revised EKC (as argued by Dasgupta *et al*. (2004)) have been found by studies like Piaggio & Padilla (2012) and Al-Sayed & Sek (2013).

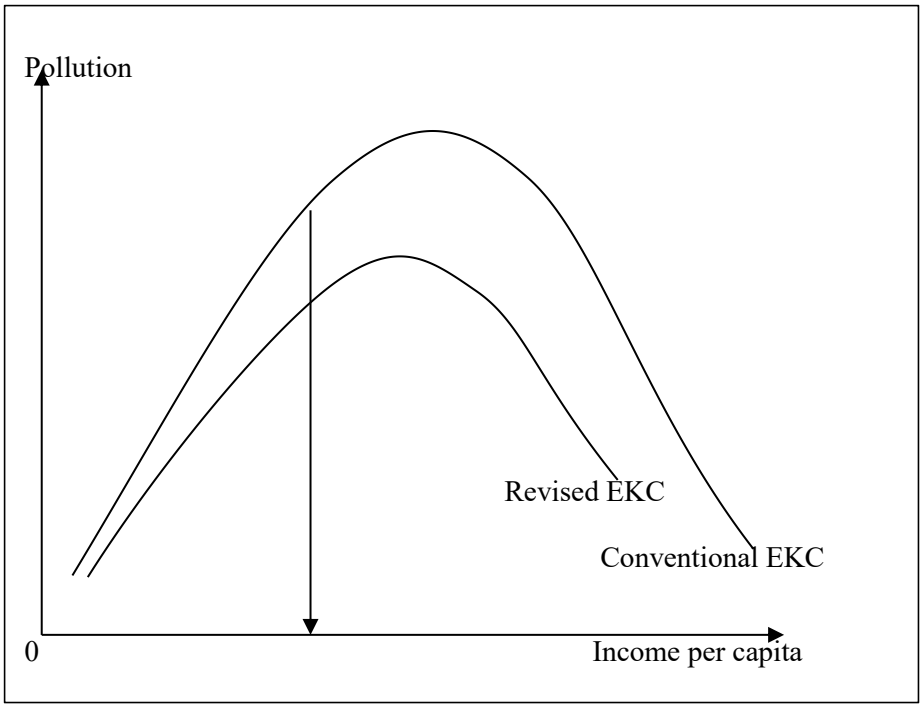


Figure 2.2: Revised and Conventional EKC
Source: Dasgupta *et al*. (2002:148)

Some scholars (for example, De Bruyn *et al*., 1998) believe that the EKC does not hold in the long run. Thus, the link between environmental pressure and economic growth would only begin with the inverted U-shape. An N-shaped curve would result from a fresh turning point that would occur above a given revenue threshold and turn the trajectory upward once again. This means that environmental degradation would come back at high growth levels (Carvalho & Almeida, 2010). This version of EKC is termed the generalized EKC by Moomaw & Unruh (1997). This version, as presented by Moomaw & Unruh (1997) and Carvalho & Almeida (2010), is shown in Figure 2.3 and Figure 2.4, respectively. For the purposes of the generalised EKC, the point at which emissions begin to decrease or increase with income can be referred to as the turning point.

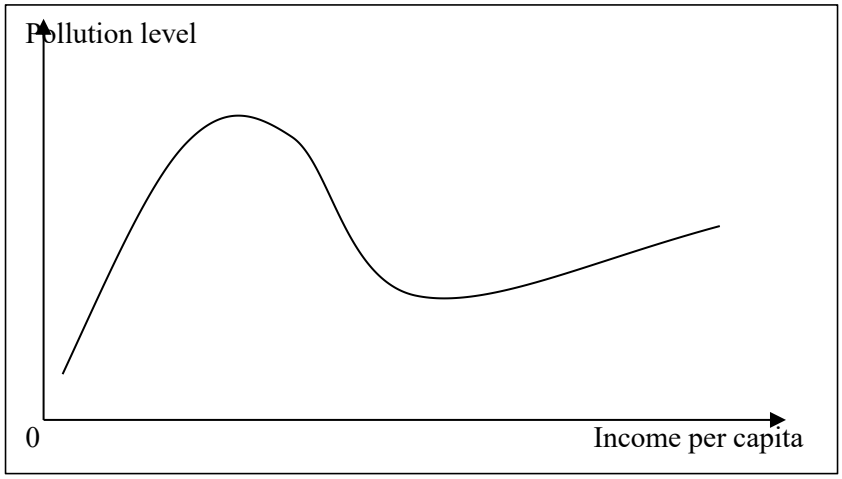


Figure 2.3: Generalised EKC

Source: Moomaw and Unruh (1997:3)

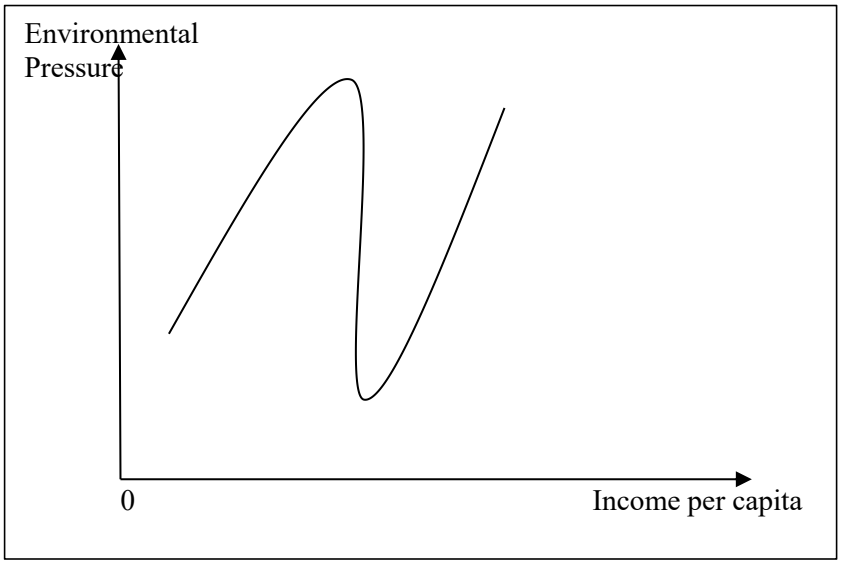


Figure 2.4: N-shaped curve

Source: Carvalho & Almeida (2010:4)

From an economic perspective, CO_2 was not viewed as a waste because it is odourless and invisible. Nevertheless, contemporary research has demonstrated that it is a waste product of numerous human endeavours. CO_2 global emissions from human activities have accelerated in recent years, increasing annually by an average of 1.1% during the 1990s to 3.8% since 2002 to 2011 (Granados & Carpintero 2009; PBL & JRC, 2014). In contrast to local pollutants like

sulphur dioxide and suspended particulate matter, carbon dioxide is a worldwide pollution. As a result, the societal costs associated with global warming compound over time and between nations. As such, from a theoretical viewpoint, the EKC hypothesis is said to be less likely for CO_2 emissions and more likely for Sulphur dioxide and suspended particulate matter or else have high turning points (Granados & Carpintero 2009; Carvalho & Almeida, 2010). That is, the free rider problem is more troublesome with CO_2 than Sulphur dioxide and suspended particulate matter (Galeotti, 2003).

Some studies (e.g., Shafik 1994; De Bruyn et al. 1998) have maintained a positive linear relationship between CO2 and GDP per capita, supporting the theory that the EKC is less likely for CO_2. However, another emerging consensus holds that the curve might be N-shaped (cubic) rather than an inverted U (e.g., Holtz-Eakin & Selden 1995; Moomaw and Unruh 1997).Either a linear or cubic relationship does not allow for an optimistic interpretation that income is beneficial for the environment (Friedl & Getzner, 2002).

Numerous investigations (e.g., Sengupta 1996; Galeotti et al. 2001; Pauli 2003) found the EKC for CO_2, despite the theoretical notion that it is less likely for CO_2. Schmalensee *et al*. (1998) posit the existence of an EKC for CO_2 during the second half of the 20th century (1950-1990) and predicted the existence of such a curve further into the future period 1990-2050 (Granados & Carpintero, 2009). This contradiction also exists for local dimension pollutants as Panayotou (1997) found the EKC for Sulphur dioxide and suspended particulate matter but Selden & Song (1994) found an N-shaped curve. This illustrates that there is no guarantee that the EKC will hold for pollutants of a local dimension rather than a global one. Therefore, it is still up for debate whether economic expansion will ultimately be good for the environment or bad for it.

2.2.8 Overview of Carbon Emissions in Sub-Saharan Africa Countries

As documented in the Climate Watch (2021), carbon dioxide (CO_2), with a share of 74% in GHG emissions in 2017, remains the main component of environmental degradation and climate change. For example, in 2016, the oil-based activities sourced 12.3 billion metric tons (or 30%) of the planet's CO_2 releases (Roberts, Babier & Vant Veld, 2019). In this context, Sub- Saharan Africa is the lower-emissions region (due to low levels of industrial development) with a share of only 4% of carbon release from the world fossil fuel sector in 2017 (Ayompe, Davis & Egoh, 2020). The region also accounts for over one-third of carbon pollution from energy use and manufacturing sector compared to 80% of such emissions worldwide, while this region is the most vulnerable to global warming (World Bank, 2012; Babatunde, 2014); and Brahmbhatt, Bishop, Zhao, Lemma, Grannoff, Godfrey & Te Velde, 2016). Sub-Saharan African economies have also experienced one of the world's highest levels of gross domestic product (GDP) growth of 4.5% for almost two decades (1995 - 2013), which persisted even during the 2008/2009 financial crisis (World Bank, 2021).

Oil resources abundance is the backbone of economies in countries such as Nigeria and the Congo Democratic Republic (COD), with around 5.8% and 5.9% average annual GDP growth over 2000 - 2019 (World Bank, 2021). Additionally, according to World Bank (2021), the GDP figures for Sub-Saharan African region (expressed in constant 2010 US dollars ($)) amounted to $664.583 billion, $812.256 billion, and $1.834 trillion in 1990, 2000 and 2019, respectively. The corresponding average annual growth has been 2.2% (for the first decade 1990–2000) and even more vigorous with 4.6% (for the following two decades 2000 - 2019).

United Nations Economic Commission for Africa (UNECA) (2012) and Talukdar & Meisner (2001) show concerns because these growth trends could have the adverse environmental impacts. Meanwhile, Sub-Saharan Africa with its infant industries, including oil companies, also became greater CO_2 emitter due to the over extraction of oil resources (to support the said growth); the oil processing requires extensive energy use, resulting in fugitive emissions, etc. (Neumayer, 2002; Friedrichs & Inderwildi, 2013; IPPC, 2014; Osabuohien, Efobi & Gitau, 2014; Hogarth, Haywood & Whitley, 2015). According to the International Energy Agency (IEA) (2020), the economic growth and oil resources dependency has raised the energy demand up to 80% of the total energy required to stimulate the region's economic activities.

The 2020 report of British Petroleum (BP, 2020) revealed that fossil fuel energy consumption in Sub-Saharan Africa, including oil resources, amounted to over 40% of the total energy mix. Such an extensive use of primary energy had a detrimental effect on the environment (Nathaniel & Iheonu, 2019; Awodumi & Adewuyi, 2020). Though Sub-Saharan Africa is the least carbon polluter region, yet its carbon emissions are growing over the years. In this regard, British Petroleum (2020) draws the attention that the CO_2 emissions in the region increased from 1070.2 million tons in 2009 to 1308.5 million tons in 2019, with an annual growth of 2.0% between 2008 and 2018. These Sub-Saharan African emissions trends could even dramatically rise to 30% by 2030 with the region's GDP and population growth projection (Ayompe et al., 2020).

2.3 Review of Related Theories

Environmental deterioration has become a focal point of academic research in the previous few decades. Environmental ideas have therefore been the subject of much study and discussion. The study's theoretical framework is based on a number of ideas, including the compact city theory,

the intergenerational equality theory, the ecological modernization theory, the environment transition theory, and the environment Kuznets Curve (EKC). The explanation of each of the theories is provided below:

2.3.1 The Environment Kuznets Curve (EKC) Hypothesis

The Environment Kuznets Curve (EKC) hypothesis explains that in the initial stages of economic development environmental degradation increases, but after a particular level of economic 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 development is associated with a higher level of environmental degradation 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).

2.3.2 Ecological Modernization Theory

As countries advance from a low to a moderate level of development, ecological modernization theory states that environmental degradation occurs because growth and expansion take precedence. However, moving to further modernization, priority is changed towards sustainable growth, sustainability of environment, technological innovations, and service base economy, thereby reducing the environmental degradation (Majeed & Mazhar, 2019).

2.3.3 Environmental Transition Theory

Environmental governance refers to the processes of decision-making involved in the control and management of the environment and natural resources. First, environmental governance is a concept in environmental policy that advocates sustainable development as the primary consideration in human activities. It views natural resources and the environment as global public goods that are not diminished when shared. This means that everybody benefits from, for example, a breathable atmosphere, stable climate. In other words, good environmental governance is fundamental not only for the well-being of the human population but also for the planet's health (Li et al., 2021). As countries shift towards an industrial or manufacturing economy, there is a greater need for energy and urban infrastructure, which leads to a rise in environmental pollution, according to the environmental transition hypothesis. However, as cities or economies become wealthier and achieve high growth then they try to improve their relationship with environment by technological innovations, stricter environmental regulations and structural changes in the economy (Majeed & Mazhar, 2019).

2.3.4 Intergenerational Equity Theory

On the other hand, the intergenerational equity paradigm places equal emphasis on social justice across generations, meaning that all generations—past, present, and future—have an equal connection with the environment. Depleting the foundation of natural resources for financial gain is no justification for favouring the current generation over the next. It is the individual's responsibility to preserve the natural environment for other species and generations (Majeed & Mazhar, 2019).

2.3.5 Structural Human Ecological Theory

The interrelated micro, meso, exo, and macrosystem structures are contained in the structural human ecology hypothesis. This theory states that a child's view of reality is initially shaped by the microsystem (family, peers, school, religious institution, health, and service), and then by the mesosystem (interaction between family and school). Then, he is impacted by the macrosystem (cultural identities) and exosystem (neighbours, social services, media, and industry) in an indirect way. Global species and the environment have a coherent effect on one another under this framework. That is, not only individuals, families, and nations' decisions and actions affect environmental quality, but natural or human created environment also affect individual behavior, health and living standard (Majeed & Mazhar, 2019).

2.3.6 The Compact City Theory

The compact city is an urban planning and urban design concept, which means good planning to achieve an overall more compact urban form. The compact city can be characterized by dense and mixed clustering of housing, social services, shops, amenities, and jobs within an integrated system supporting efficient land and energy use. It also entails the designation of green belts as

boundaries of development to ensure environmental and agricultural protection (Westerink et al., 2013). Because it results in economies of scale for public infrastructure and lessens environmental strain, the compact city hypothesis clarifies the advantages of increased urbanisation. In contemporary debate, compact city models are legitimized by contributing to certain urban forms, contributing to lower energy consumption and lower pollution levels. Compact city strategies are considered a precondition for lowering CO2 emissions. Therefore, the compact city concept has become central to the development of urban sustainability politics.

2.4 Methodological Review of the Mean Group (MG) and the Pooled Mean Group (PMG) Regression

Pesaran, Shin, and Smith (1999) propose two estimating procedures, the Mean Group (MG) and the Pooled Mean Group (PMG), that allow for a higher degree of parameter heterogeneity in regressions than the other estimators like pooled OLS or static fixed effects estimators. The PMG estimator provides a way of at least partly overcoming this problem by assuming homogeneity of the long run coefficients while allowing the short run coefficients and error variances to differ across countries. The MG estimator allows for heterogeneity of all coefficients, intercepts and slopes, by estimating a separate equation for each country while the coefficients for the whole panel are computed as unweighted averages of the individual coefficients.

The Pooled Mean Group (PMG) estimator considers a lower degree of heterogeneity since it imposes homogeneity in the long run coefficients while still allowing for heterogeneity in the short run coefficients and the error variances. This estimator allows the consideration of a higher degree of heterogeneity among countries than is common in other estimators. The basic assumptions of the PMG estimator are (see Pesaran, Shin & Smith, 1999) the error terms are

serially uncorrelated and are distributed independently of the regressors, i.e., the explanatory variables can be treated as exogenous (This can be achieved by introducing a sufficient number of lags in the model); ii) there is a long run relationship between the dependent and explanatory variables; and iii) the long run parameters are the same across countries. This estimator is also flexible enough to allow for long run coefficient homogeneity over a single subset of regressors and/or countries. It is also possible to test for the suitability of the PMG estimator relative to the MG estimator based on the consistency and efficiency properties of the two estimators, using a likelihood ratio test or a Hausman test.

MG considers heterogeneity in both slope and constant, while PMG only assumes fix effect heterogeneity in the long-run specification. It means, PMG uses Maximum Likelihood to get the long-run equation, but MG estimates different coefficients (constant and slope) for each panel separately.

2.5 Empirical Literature

A number of empirical investigations have been carried out to find the nexus between financial development and environmental degradation as well as between economic growth and environmental degradation 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: financial development and environmental degradation studies for developed and developing countries as well as economic growth and environmental degradation studies for developed and developing countries.

2.5.1 Financial Development and Environmental Degradation: Empirical Evidence from Developed Countries

The review of previous researches that investigated the relation between financial development and environmental deterioration in developed countries is carried out in this section.

Joe-Ming, Ku-Hsieh & Chin-Ho (2015) examine the relations among CO_2 emissions, energy use, GDP, and financial development for 25 OECD countries over the 1971–2007 periods. From the results of the panel FMOLS and the cross-sectional dependence regression, the findings did not confirm the EKC for OECD countries. Moreover, the results present that the coefficient of financial development to CO_2 emissions is negative and statistically significant for eight countries (Austria, Denmark, Germany, Ireland, the Netherlands, Norway, Portugal, and the U.S.).

Using panel data from 40 European nations, Ayeche, Barhoumi, and Hammas (2016) investigated the relationship between CO_2 emissions, trade openness, financial development, and economic growth using the General Linear Model (GLM). The results indicate that there is evidence of a bidirectional causal relationship between trade openness and CO_2 emissions, financial development and trade openness, trade openness and CO_2 emissions, and economic growth. The environmental Kuznets curve's existence was verified by the relationship between CO_2 and economic growth. Moreover, a feedback hypothesis positing a bidirectional causal relationship between financial development and trade openness was discovered. Additionally, it was shown that there is no causal relationship between financial progress and environmental degradation as determined by CO_2 emissions. Ultimately, a two-way causal relationship was also

demonstrated between trade openness and economic growth, as well as between financial development and economic growth.

Piñeiro-Chousa, Tamazian and Vadlamannati (2017) investigated the linkages between financial development and environmental degradation for Brazil, Russia, Indonesia, and China (BRICs) for the period 1992 to 2004. As measure of robustness, they also introduce and examine behavior of results considering USA and Japan. The feasible general least squares (FGLS) procedure was used to estimate the environmental impact of economic and financial development. Findings confirm the existence EKC as the results show that economic development decreases the environmental degradation with higher levels of economic growth. The results also reveal that financial development is an essential factor to decrease the CO_2 per capita emissions.

Shahbaz, Nasir and Roubaud (2018) investigate the determinants of carbon emissions in France by accounting for the significant role played by foreign direct investment (FDI), financial development, economic growth, energy consumption and energy research innovations in influencing CO_2 emissions function over the period 1955 – 2016. The empirical results support the occurrence of cointegration among the time series, which was confirmed using the bootstrapping bounds testing technique. Furthermore, results show that while energy research discoveries have a negative effect on French carbon emissions, foreign direct investment has a beneficial influence. Development in the financial sector reduces carbon emissions, which enhances the environmental quality of France. Since FDI deteriorates the environment, it validates the pollution-haven theory in France. Financial growth also implies that financial stability and advances in energy research are necessary conditions for enhancing environmental quality. On the other hand, there is a positive correlation between energy use and carbon

emissions. Nonetheless, the environmental Kuznets curve (EKC) is validated by the inverted-U link between economic growth and CO_2 emissions.

Li and Ouyang (2019) investigate the dynamic impacts of financial development, human capital, and economic growth on CO_2 emission intensity in China for the period 1978–2015 employing an autoregressive distributed lag (ARDL) approach. The estimations show three main findings. First, financial openness measured by net FDI inflows can significantly reduce CO_2 emission intensity in both the short-term and the long-term, whereas the effects of both financial scale and financial efficiency are limited and insignificant. Second, there exists an inverted N-shaped relationship between human capital and CO_2 emission intensity: improving human capital first decreases CO_2 emission intensity (before 1992), then increases it in the short-run (after 1992), and, finally, lessens it in the long-run. Last, raising per capita income can also significantly lower CO_2 emission intensity in the long-run.

Majeed and Mazhar (2019) examine the effect of financial development on environmental degradation using ecological footprint as proxy for environmental degradation for a panel of 131 countries from 1971 to 2017. Pooled ordinary least squares (OLS), random effects, fixed effects, Driscoll-Kraay (DK) standard errors, and system generalised method of moments (GMM) are used in the empirical study. The results show that all financial development indicators—that is, domestic credit to the private sector, domestic credit from banks to the private sector, and domestic credit from the financial sector—significantly contribute to the improvement of environmental quality by lowering the ecological footprint. In contrast to other indicators of financial development, domestic lending to the private sector has a greater impact. In a similar vein, a notable decline in the ecological footprint has coincided with urbanisation. On the other hand, by expanding the ecological footprint, energy consumption, FDI, and GDP per capita

degrade environmental quality. The "pollution haven hypothesis" for the world economy is also supported by the study.

Shahbaz, Haouas, Sohag, and Ozturk (2020) use the CO2 emissions function for the United Arab Emirates from 1975QI to 2014QIV to analyse the relationship between financial development and environmental degradation by accounting for economic growth, energy consumption, and economic globalisation. By employing an inventive accounting technique, the Toda-Yamamoto causality test was utilised to examine the causal relationship between the variables and assess the robustness of the causal association. Results indicate that CO2 emissions rise as the financial system develops. Environmental deterioration was shown to be positively correlated with economic expansion, but carbon emissions and globalisation were favourably correlated. Financial development and CO_2 emissions have an inverse N-shaped and U-shaped association, respectively. Moreover, environmental deterioration causes financial development and financial development in the Granger sense results from environmental deterioration.

Shogbande and Ogbeifun (2021) examine the effect of financial development and energy consumption on environmental sustainability in Organization for Economic Cooperation and Development (OECD) countries for the period 1980 – 2019 using the standard fixed effects and the Arellano-Bover/Bundell Bond dynamic panel approach. The empirical results revealed that financial development index and energy efficiency reduce carbon emissions and promoting sustainability in the OECD.

Ibrahim and Vo (2021) examine the tripartite linkages among innovation, financial development and pollution relationships using data from 27 selected industrialized countries spanning 1991–2014. The two-step system generalized method of moments (GMM) and Granger causality test

was used to estimate the data. Findings reveal that, while innovation lowers environmental pollution, beyond a certain threshold level, higher innovation exacerbates environmental degradation. Furthermore, while improved financial development increases pollution, higher innovation dampens the environmental quality–reducing effect of finance. Results from the panel causality tests also reveal a feedback causal linkage between innovation and ecological footprint, and a one-way causality from CO_2 emissions to innovations. However, irrespective of the indicator of environmental pollution, financial development and pollution evolve independently, albeit differences at the country levels.

Shahbaz, Destek, Dong and Jiao (2021) investigate the time-varying impact of financial development on carbon dioxide (CO_2) emissions for G-7 countries over a long historical period. The study analyzes historical data from 1870 to 2014 for each country using bootstrap time-varying co-integration (TVC) and bootstrap rolling window estimation approaches. In addition, the polynomial trends of the estimated parameters are obtained to observe the relation between financial development and carbon emissions. The findings reveal that the impact of financial development on CO2 emissions over a long history is M-shaped in Canada, Japan, and the US; inverted N-shaped in France, Italy, and the UK; and inverted M-shaped (W-shaped) in Germany.

Khan, Khan and Muhammad (2021) examined the impact of financial development and energy consumption on carbon emissions for 128 countries, between 1990 and 2017, using seemingly unrelated regression and GMM and reported that financial development positively impacted carbon emissions. Lv & Li (2021) investigated the spatial effects of financial development on carbon emissions across 97 countries, from 2000 to 2014, and reported that financial development has a negative effect on carbon emissions.

Habiba and Xinbang (2022) examine the impact of overall financial market development, institution development, and their sub-indices on CO_2 emissions. Four financial market indices (overall financial market development, FM-access, FM-depth, and FM-efficiency) and four financial institution indices (overall financial institution development, FI-access, FI-depth, and FI-efficiency) were used to measure financial development. The study used two-stage system GMM and panel data of developed and emerging nations for the period 2000–2018. The empirical results reveal that the overall financial market development and its sub-indices (FM-access, FM-depth, and FM-efficiency) reduce CO_2 emissions in developed and emerging nations. The outcome further display that the overall financial institution development and its sub-indices such as FI-access, FI-depth, and FI-efficiency foster the environment quality in developed economies, while these indices impede the environmental quality in emerging economies. The usage of renewable energy is found to be a viable solution to mitigate the CO_2 emissions in both groups of countries.

2.5.2 Financial Development and Environmental Degradation: Empirical Evidence from Developing Countries

The review of previous researches that investigated the relation between financial development and environmental degradation in developing countries is carried out in this section.

The empirical research on financial development and environment nexus started with the pioneer studies of Aufderheide & Rich (1988), Schmieding & Zorraquin (1998). Aufderheide & Rich (1988) highlighted the role of multilateral banks in affecting the environmental quality. They contended that the financial assistance mechanism of the World Bank frequently fails to consider the environmental consequences of the loanable monies, hence giving rise to grave

environmental issues. For example, in India, microfinance for cotton production rendered the anticipated agricultural area worthless by depleting the soil, the Grand Bereby rubber project led to the degradation of tropical forestlands, and financing for energy capital caused soil erosion. Schmiding & Zorraquin (1998) concluded that more often financial institutions encourage short-term goals and ignore the associated environmental risks, thereby leading to higher natural resource exploitations.

Ozturk & Acaravci (2013) examined the causal link between financial development, trade, and carbon emissions in Turkey between 1960 and 2007 and found that financial development had no significant effect on carbon emissions in the long run.

Moghadam & Lotfalipour (2014) investigate the effect of financial development on environmental quality in Iran. For this purpose, the statistical data over the period from 1970 - 2011 were used. Also by using the Auto Regression Model Distributed Lag (ARDL), short-term and long-term relationships among the variables of model were estimated and analyzed. The findings indicate that while increased trade openness lessens environmental harm in Iran, financial development speeds up environmental deterioration. According to the error correction coefficient, 53% of imbalances would be justified and would eventually approach their long-term procedure over each period. Tests for structural stability demonstrate that the calculated coefficients remained constant throughout the time.

Boutabba (2014) examines the long-run equilibrium and the existence and direction of a causal relationship between carbon emissions, financial development, economic growth, energy consumption and trade openness for India for the period 1970 – 2008 employing the Autoregressive Distributed Lag (ARDL) bounds testing procedure. The outcomes submit that

there is evidence on the long-run and causal relationships between carbon emissions, financial development, income, energy use and trade openness. Financial development has a long-run positive impact on carbon emissions, implying that financial development improves environmental degradation. The results also confirm the existence of EKC hypothesis in the Indian economy.

Ziaei (2015) examined the link between financial development, energy consumption, and carbon emissions across 13 European and 12 East Asian and Oceania countries for the period 1989 to 2011 using a vector autoregressive model and reported that the stock market influenced energy consumption and affected the environment.

Omri, Daly, Rault, and Chaibi (2015) examine the causal link between carbon emission, financial development, trade, and economic growth in MENA countries using a sample of 12 Middle East and North Africa (MENA) countries for the period 1990 - 2011. Simultaneous equations GMM-estimation and granger causality test were used to analyze the data. There is unidirectional causality running from financial development to economic growth and from trade openness to carbon emission, and further on confirmed the existence of Environmental Kuznets Curve in MENA countries.

Hamdan, Ab-Rahim and Fah (2018) examines the link between financial development and environmental deterioration in ASEAN-5 countries namely Indonesia, Malaysia, Philippines, Singapore, and Thailand over the period of 2000 to 2014. The Vector Error Correction Model (VECM) Granger Causality and Fully Modified Ordinary Least Square (FMOLS) are used in this study to examine the short-run and the long-run as well as the causality relationship among the variables. Variables employed in this study are carbon dioxide (CO_2) emissions, foreign direct

investment (FDI), private domestic credit (DC), and market capitalization (MC). The empirical findings show that there is a bidirectional causality relationship between the CO_2 and FDI. Meanwhile, there is a unidirectional causality running from CO_2 to DC, MC to FDI, and MC to DC respectively.

Mesagan and Nwanchukwu (2018) examine the determinants of environmental quality in Nigeria, focusing on the role of financial development covering the period from 1981 to 2016. Data on urbanisation, per capita income, environmental degradation, energy consumption, trade intensity, and capital investment are analysed in the study using the ARDL bounds testing technique. Principal component analysis was used to create the environmental deterioration index (PCA). Empirical findings indicate that while investment and urbanisation are negligible in the model, income, financial development, energy consumption, and trade are relevant in determining environmental quality. The results indicate that while affluence and urbanisation contribute to environmental deterioration unidirectionally, there is no causal relationship between capital investment, financial development, and environmental quality. Furthermore, there is a two-way causal relationship between environmental deterioration and energy usage.

Zaidi, Zafar, Shabaz and Hou (2019) examined the relation between financial development and carbon emissions for Asian Pacific Economic Cooperation nations between 1990 and 2016 using Westerlund cointegration techniques and a continuously updated bias-corrected approach. This study demonstrated that financial development significantly reduced carbon emissions.

Lestari, Effendi and Priyono (2020) examines the effects of financial development and economic growth on environmental degradation in Asian emerging markets using financial development from banking sector and capital market sector, economic growth, Foreign Direct Investment

(FDI), and urbanization variables that are major determinants of CO_2 emission as a proxy of environmental degradation. The periods considered were 1980 – 2018 for banking model, and 1996 – 2018 for financial sector model (banking sector and capital market sector). Fully Modified OLS and Dynamic OLS were used to estimate the data. The empirical finding revealed that in Asian emerging markets there is positively long-term relationship between financial developments from banking model with environmental degradation. However, there was no long- term relationship between financial developments from financial sector model with environmental degradation. Moreover, the quadratic negative signed for economic growth showed the existence of Environmental Kuznets Curve (EKC).

Longe, Bolaji, Soyemi, and Adebayo (2020) explores the short-run and long-run dynamic link between financial development and carbon emission as well as the causal linkage between financial development and carbon emission in Nigeria from 1971 to 2017 employing the Vector Error Correction Model (VECM) approach. Findings revealed that financial development had a positive impact in the short-run and negative impact in the long-run on carbon emission in Nigeria, while Gross Domestic Product (GDP) and Energy consumption had a negative impact in the short-run and positive impact in the long-run on carbon emission. The causality test revealed that jointly, financial development, output and energy consumption causes carbon emission, while no direction of causality was found between financial development and carbon emission in Nigeria.

Nyarkoa and kaya (2021) examines the relationship between financial development and environmental degradation using a panel data of 36 middle-income countries from the timeframe 1996 - 2012. Additionally, this study also evaluates the hypothesis of the environmental Kuznets curve. For the empirical analysis, pooled ordinary least squares, fixed effects model, random-

effects model, and quantile regressions are applied. The empirical findings from the random-effects model reveal that financial development mostly has a negative relationship with environmental degradation when climate change vulnerability is used as an indicator. This indicates the importance of the green financial sector, which promotes green technological investments, thus combating the climate change challenge contemporary society is facing. However, the quantile regression model generated mostly insignificant and inconsistent results. Lastly, findings show evidence of both the N-shaped and inverted N-shaped EKC when using both random-effects model and quantile regressions, indicating that the original inverted U-shaped EKC does not hold in the long run.

Tahir, luni, Majeed and Zafar (2021) examined the impact of financial development on environmental quality in South Asian economies from 1990 to 2014 employing Dynamic Ordinary Least Squares (DOLS) and the result show that financial development contributed to carbon emissions.

Khuky (2021) employing annual time series data from 1983 to 2019, examines the impact of economic growth, exports, energy consumption, and financial development on environmental deterioration in Bangladesh. The long-run cointegration of variables is investigated using Dynamic Ordinary Least Squares (DOLS) and Fully Modified OLS (FMOLS) approaches. The co-integration study demonstrates a long-term relationship between dependent variable and independent variables. The findings reveal that in the long run the primary determinants of carbon dioxide emissions are economic growth, energy consumption, export, and financial development are the primary determinants of carbon dioxide emissions. Except for energy consumption, the result shows that financial development, economic development, and export have a statistically significant long-run co-integration with environmental degradation. The

Environmental Kuznets Curve, a quadratic term for economic expansion, demonstrates a negative impact on environmental degradation (EKC).

Hasan, Oudat, Alsmadi, Nurfahasdi and Ali (2021) examines the causality relationship between financial development and carbon dioxide (CO_2) emission in Bahrain by adopting time series data from 1980–2018. The vector error correction model (VECM) was employed to analyze the data. The domestic per capita was used as a proxy of economic growth, while financial development is measured by domestic credit provided by the financial sector. The results indicate that there is a long-term association amongst all intended variables at a 5% significant level. Meanwhile, only financial development has an impact on carbon emission in the short term. However, the study findings did not support the hypothesis of the environmental Kuznets curve (EKC).

Musa, Chindo and Maijama'a (2021) investigated the impact of financial development on CO_2 emissions in Nigeria from 1981 to 2019. The autoregressive distributed lag model long-and-short run models results indicated that financial development and income level significantly negatively impact the CO_2 emissions. The Granger causality result revealed bidirectional causality from financial development to CO_2 emissions, income level to CO_2 emissions, and financial development to income level. The variance decomposition analysis indicates that financial development and income level have contributed less to CO2 emissions, and impulse response function results revealed that CO_2 emissions respond negatively to shocks in financial development and income level

Aljadani (2022) test the technology effect hypothesis on environmental mitigation in the case of Saudi Arabia (KSA) over the period 1970–2016 and the with the Autoregressive Distributed Lag

(ARDL) model used for empirical investigation. The empirical findings show that financial development and technology have an inverse and significant impact on environmental degradation. The technology effects of financial development have an unfortunate effect on environmental mitigation. Finally, lower environmental mitigation is associated with a deepening in total population and affluence. Moreover, findings from the pairwise Granger causality test point that there is no causality running from both financial development and technology to the effect of technology among KSA. On the opposite, economic growth Granger, cause environmental quality.

2.5.3 Economic Growth and Environmental Degradation: Empirical Evidence from Developed Countries

Grossman and Krueger (1991) explore the impact of environment on the North American Free Trade Agreement (NAFTA). Their result shows an inverted-U relationship between some pollutant emissions such as sulfur dioxide or smoke and per-capita income for the United States prior to the NAFTA. They were the first to confirm the existence of the EKC hypothesis. Similarly, Shafik & bandyopadhyay (1992) estimated EKCs for ten indicators of environmental degradation for 149 countries over the period 1960-1990. The results confirmed an inverted-U relationship between income and ambient concentrations of air pollutants.

In a related study, 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 SO2), their turning point for these pollutants is greater than $8,000. They found that nitrogen oxides (NOx) 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 & 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, & 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.

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.

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.

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. Caporale, Claudio-Quiroga & Gil-Alana (2021) examines the relationship between the logarithms of carbon dioxide (CO2) 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.

2.5.4 Economic Growth and Environmental Degradation: Empirical Evidence from Developing Countries

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.

Gao & Zhang (2014) explores the causal relationship among electricity consumption, economic growth and CO2 emissions for a group of 14 sub-Sahara African (SSA) countries from 1980 to 2009 using panel cointegration and panel vector error correction modelling methods. The findings demonstrate that in the long run electricity consumption has a statistically significant positive impact on CO2 emissions. The results also reveal that the inverted U-shaped Environmental Kuznets Curve (EKC) hypothesis exists in the SSA countries' case. The panel causality tests indicate that there is short-run unidirectional causality running from economic growth to CO2 emissions and electricity consumption respectively.

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.

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 CO2 emissions. In the medium and long terms, the association between CO2 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 CO2 emissions in Brazil, China, and Indonesia will gradually decline as wealth rises. Nonetheless, it was shown that CO2 emissions and income in India were positively correlated; as a result, rising income over time will not result in a decrease in CO2 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, *et al*., (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.

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 CO2 emissions, an inverted U-shaped relationship between trade and CO2 emissions, and a positive influence from energy consumption and urbanisation were all supported by their estimated findings from the FMOLS and DOLS.

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. Using a system GMM model, Wabena-Twerefou, Danso-Mensah, and Bokpin (2017) conducted a panel research to investigate the effects of globalisation and economic growth on carbon emissions in 36 SSA nations between 1990 and 2013. The EKC hypothesis is supported by the evidence, as globalisation is found to impair environmental quality via raising carbon emissions.

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.

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 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 CO2, the relationship between urbanisation and the consumption of combustible renewables and trash has a beneficial effect.

Ziaei (2018) investigate the effects of interest rate spread shocks before and after the implementation of LSAPs (Federal Reserve large-scale asset purchases) on energy consumption

for different sectors. The US monthly data (2002-2015) for interest rate spreads, such as term, corporate, and mortgage rate spreads, and paper bills, and the energy used by sector (residential, commercial, industrial, transportation, and electric power) were used in this study. Findings provided evidence that a cut in interest rate spreads was seen as a positive signal in the energy market. Also, that the mortgage spread (MORS) shock had a significant effect on the energy consumed by the residential sector, after the implementation of unconventional monetary policies. Likewise, paper bill shocks had a significant effect on energy consumption for different sectors before the implementation of unconventional monetary policies. The results indicated that the Federal Fund Effective rate had a weak impact on components of energy consumption before the implementation of quantitative easing policies by the Federal Reserve.

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. 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 NH4 emissions as a proxy).

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.

Isiksal, Samour and Resatoglu (2019) explore the impact of real interest rates (RIN), income, trade, foreign direct investment (FDI), and energy consumption on Turkey's carbon dioxide emissions (CO_2) over the period from 1980 to 2014. ARDL bounds test and the vector error correction model (VECM) were the estimation techniques. The empirical results demonstrate that RIN negatively effects CO_2 emissions. This impact is also supported through energy, income, and FDI channels. It is suggested that policy makers should promote the stability of the real interest rates channel to reduce CO_2 emissions and encourage the renewable energy investment through the production of electricity using renewable sources.

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 & Mamman (2020) investigated the EKC for selected oil producing African countries. They proved the EKC theory for methane gas emissions only.

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.

Dasuki and Olubusoye (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. According to the study's findings, most African nations would see increasing emissions as their economies expand.

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.

Ouédraogo, Peng, Chen, Hashmi and Sal (2021) examine the environmental Kuznets curve (EKC) theory, supplementing the role of oil resources and energy consumption in carbon dioxide (CO_2) emissions using the annual data of 11 African oil-producing countries from 1980 to 2014 using the advanced panel cointegration and panel ARDL techniques coupled with Granger non-causality analysis to account for cross-sectional dependence and heterogeneity. The results of the augmented mean group (AMG) reveal that oil resources abundance degrades the environmental quality in Angola while abating CO_2 emissions in Algeria, Gabon, Morocco, and Nigeria. Contrarily, energy consumption escalates pollution in the Congo Democratic Republic, Côte d'Ivoire, Gabon, Morocco, and Tunisia. The outcome supports the EKC hypothesis only in Cameroon, Côte d'Ivoire, and Nigeria while exhibiting a U-shaped curve in Algeria and Morocco. Causality analysis unveils that oil resources Granger cause energy consumption, suggesting the balance between renewable and non-renewable energy sources

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. 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.

2.6 Summary Table of Reviewed Empirical Literature

Table 2.1 summarizes the reviewed empirical literature.

Table 2.1: Tabular Summary of the Empirical Literature Reviewed

S/N	Author(s)/year	Country	Methodology	Sampled Periods	Findings
1	Grossman and Krueger (1991)	United States	Ordinary Least Squares (OLS) regression	1960 – 1990	Findings confirmed the existence of the EKC hypothesis
2	Shafik and bandyopadhyay (1992)	149 Countries	Ordinary Least Squares (OLS) regression	1960 – 1990	Results for the majority of the nations supported the presence of the EKC theory.
3	Moomaw and Unruh (1997)	16 OECD Countries	Ordinary Least Squares (OLS) regression	1970 – 1980	Results for the majority of the nations supported the presence of the EKC theory.
4	Friedl and Getzner's (2003)	Austria	Ordinary Least Squares (OLS) regression	1960 – 1999	Results did not support the existence of the EKC theory.
5	Azomahou, Laisney and Van (2006)	100 countries	Ordinary Least Squares (OLS) regression	1960 – 1996	Results for the majority of the nations supported the presence of the EKC theory.
6	Akbostanci, Türüt-Aşık and Đpek-Tunç (2009)	Turkey	Ordinary Least Squares (OLS) regression	1968 - 2003.	Findings could not confirmed the existence of the EKC hypothesis
7	Choi, Heshmati and Cho (2010)	China, Korea, and Japan	Ordinary Least Squares (OLS) regression	1971 – 2006	Results for Korea and Japan supported the EKC theory, however China displayed an N-shaped curve.
8	Narayan and Narayan (2010)	43 developing countries	Auto Regressive Distributed Lag	1980 – 2004	In 35% of the sample, the results supported the EKC

			(ARDL) bounds testing approach		theory.
9	Esteve and Tamarit (2012)	Spain	Ordinary Least Squares (OLS) regression	1957 – 2007	Results did not support the existence of the EKC theory.
10	Saboori et al. (2012)	Malaysia	Auto Regressive Distributed Lag (ARDL) bounds testing approach and VECM causality est	1980–2009	Results validated the EKC theory. There is no evidence of short-run causation, according to the VECM test, although economic growth has a unidirectional long-run causal relationship with carbon.
11	Shahbaz, Lean and Shabir (2012)	Pakistan	Ordinary Least Squares (OLS) regression and Granger Causality	1971 – 2009	In 35% of the sample, the results supported the EKC theory. Additionally, they discovered a one-way causal association between CO2 emissions and economic development. In the short and long terms, energy use raises CO2 emissions. Long-term trade openness lowers CO2 emissions, while short-term effects are negligible.
12	Tiwari, Shahbaz, and Adnan (2013)	India	ARDL bounds testing approach and Granger Causality test	1966–2011	Results show that there is a long- and short-term Environmental Kuznets Curve (EKC). Moreover, trade openness and coal usage both increase CO2 emissions. The causality finding shows that there is feedback causation between CO2 emissions and economic growth, and a similar result was found between CO2 emissions and coal use. Additionally, trade liberalisation increases the usage of coal, CO2

					emissions, and economic development.
13	Aduebe (2013)	Nigeria	ARDL bounds testing approach	1971 to 2011	Findings supports the EKC hypothesis
14	Gao and Zhang (2014)	14 sub-Sahara African (SSA) countries	Vector Error Eorrection Modelling Method (VECM) and Granger Causality Test	1980 – 2009	Results back up the EKC theory. The results of the causality tests show that there is a short-run, unidirectional causal relationship between economic growth and the consumption of electricity and CO2 emissions, respectively. Long-term bidirectional causation exists simultaneously between the use of electricity and economic expansion, the use of electricity and CO2 emissions, and the economic expansion and CO2 emissions.
15	Moghadam and Lotfalipour (2014)	Iran	Auto Regression Model Distributed Lag (ARDL)	1970 - 2011	Results indicate that while increased trade openness lessens environmental harm, financial development speeds up environmental deterioration.
16	Boutabba (2014)	India	Autoregressive Distributed Lag (ARDL) bounds testing procedure	1970 – 2008	The results show a causal association between trade openness, income, energy usage, financial development, and carbon emissions. Financial development appears to mitigate environmental deterioration since it has a long-term positive effect on carbon emissions. Additionally, the Granger causality test shows a long-

					term, unidirectional causal relationship between energy usage and carbon emissions and financial development. Additionally, the EKC hypothesis' existence was verified.
17	Ben-Jeblil, Ben-Youssef and Ozturk (2015) over.	24 SSA countries	OLS and FMOLS	1980–2010	Findings did not support the EKC hypothesis. ALSO, Export and import have and positive and negative impact on carbon emissions respectively in SSA
18	Joe-Ming, Ku-Hsieh Chen and Chin-Ho (2015)	25 OECD countries	FMOLS regression	1971–2007	Findings did not support the existence of the EKC for OECD countries. Moreover, the results present that the coefficient of financial development to CO2 emissions is negative and statistically significant for eight countries (Austria, Denmark, Germany, Ireland, the Netherlands, Norway, Portugal, and the U.S.).
19	Ziaei (2015)	13 European and 12 East Asian and Oceania countries	Vector Autoregressive (VER) Method	1989 – 2011	Findings show that stock market influenced energy consumption and affected the environment
20	Omri, Daly, Rault, and Chaibi (2015)	12 Middle East and North Africa (MENA) Countries	GMM and granger causality test	1990 – 2011	The results validated the existence of an environmental Kuznets curve in the Middle East and North Africa (MENA) and indicated a strong bidirectional causal relationship between economic growth and carbon emission as well as a positive relationship between trade openness and

					economic growth. Additionally, there is a unidirectional causal relationship running from trade openness to carbon emission and from financial development to economic growth.
21	Al-Mulali and Ozturk (2016)	27 advance economies	Fully Modified Ordinary Least Square, Vector Error Correction Model and Granger Causality Test	1990 – 2012	Findings confirmed the existence of the EKC hypothesis
22	Sinha and Sudipta (2016)	Brazil, Russia, India, and China (BRIC countries)	generalized method of moments (GMM) method	1980 – 2013	Results show that there is a bidirectional causal relationship between economic growth and CO2 emissions. The relationship between CO2 emissions and trade volume, economic growth and human development, and CO2 emissions and trade volume all support the feedback theory. In addition to demonstrating the unidirectional relationship between trade volume and economic growth, this study established the validity of the environmental Kuznets curve.
23	Alam, Murad, Noman, and Ozturk (2016)	India, Indonesia, China, and Brazil	Autoregressive Distributed Lag (ARDL) bounds test approach	1970 – 2012	Results indicate that whereas China only supports the Environmental Kuznets curve theory over the long term, Indonesia and Brazil appear to have an Environmental Kuznets curve in both the short and long terms. In the short and

					long terms, India does not support the Environmental Kuznets Curve hypothesis.
24	Alege, et al., (2016)	Nigeria	Ordinary Least Squares (OLS) regression	1970-2011	Findings rejects the existence of an EKC hypothesis
25	Ayeche, Barhoumi and Hammas (2016)	40 European countries	Generalized Least Squares (GLS) and Granger Causality Test	1985 - 2014	The results indicate a bidirectional causal relationship between trade openness and CO2 emissions, financial development and trade openness, trade openness and CO2 emissions, and economic growth and all of these relationships. It was determined that the environmental Kuznets curve existed based on the relationship between CO2 and economic growth.
26	Kwakwa and Adu (2016).	selected sub-Saharan Africa (SSA) countries	FMOLS and DOLS	1980 – 2010	The results verified a positive impact from energy consumption and urbanisation, an inverted U-shaped association between trade and CO2 emissions, and an inverted U-shaped relationship between income and CO2 emissions.
27	Piñeiro-Chousa, Tamazian and Vadlamannati (2017)	Brazil, Russia, Indonesia, and China (BRICs) and USA and Japan	Feasible General Least Squares (FGLS) procedure	1992 to 2004	The presence of the EKC is supported by the findings, which indicate that as economic growth increases, environmental deterioration diminishes as well. The findings also show that reducing CO2 emissions per person requires financial growth.

28	Twerefou, Danso-Mensah, and Bokpin, (2017)	36 SSA countries	System GMM	1990–2013	The EKC theory is supported by the findings, which also show that globalisation lowers environmental quality by raising carbon emissions.
29	Jardón, Kuik and Tol (2017)	20 Latin American and Caribbean countries	Ordinary Least Squares (OLS) regression	1971 – 2011	Findings rejects the existence of an EKC hypothesis
30	Mesagan and Nwanchukwu (2018).	Nigeria	ARDL bounds testing approach	1981 - 2016	The results demonstrate that while investment and urbanisation are not significant in the model, income, financial development, energy consumption, and trade are important in determining environmental quality. Additional findings show that while income and urbanisation contribute to environmental deterioration unidirectionally, there is no causal relationship between capital investment, financial development, and environmental quality. Furthermore, there is a two-way causal relationship between environmental deterioration and energy usage.
31	Shahbaz, Nasir and Roubaud (2018)	France	Ordinary Least Squares (OLS) regression	1955 – 2016	The results show that whereas energy research discoveries have a negative effect on French carbon emissions, foreign direct investment has a favourable effect on carbon emissions. Development in the financial sector reduces carbon

					emissions, which enhances the environmental quality of France. Since FDI deteriorates the environment, it validates the pollution-haven theory in France. Financial growth also implies that financial stability and advances in energy research are necessary conditions for enhancing environmental quality. On the other hand, there is a positive correlation between energy use and carbon emissions. Nonetheless, the environmental Kuznets curve (EKC) is validated by the inverted-U link between economic growth and CO2 emissions.
30	Ketenci (2018)	Russian	ARDL bounds test method	1991 – 2016	The results disprove the existence of the EKC theory. Additionally, it is discovered that trade openness has no effect on carbon emissions, but energy consumption, real income, education, and urbanisation levels do.
32	Kwakwa, Alhassan and Aboagye (2018)	Tunisia	Ordinary Least Squares (OLS) regression	1971 – 2016	The results show that financial development lowers CO2 emissions from manufacturing, construction, and residential and building sectors, but increases CO2 emissions overall, CO2 emissions from the transportation sector, and CO2 consumption from liquid fuel. In contrast to CO2 emissions, which are shown to be negatively

					impacted by the extraction of natural resources, CO2 emissions from the manufacturing, building, and gaseous fuel use sectors are positively impacted. It is discovered that the source of CO2 emissions in Tunisia determines whether the EKC hypothesis holds true or not in the context of financial development and the extraction of natural resources.
33	Sarkodie (2018)	17 African countries	the ECM and Panel cointegration approach	1971 – 2013	Findings confirmed the EKC hypothesis
34	Ziaei (2018) US	USA	Ordinary Least Squares (OLS) regression	2002 - 2015	Results show that in the energy market, a decrease in interest rate spreads was interpreted favourably. It is also noteworthy that following the adoption of unconventional monetary policies, the residential sector's energy consumption was significantly impacted by the mortgage spread (MORS) shock.
35	Hamdan, Ab-Rahim and Fah (2018)	ASEAN-5 countries namely Indonesia, Malaysia, Philippines, Singapore, and Thailand	Vector Error Correction Model (VECM) Granger Causality and Fully Modified Ordinary Least Square (FMOLS)	2000 - 2014	Results indicate that FDI and CO2 have a bidirectional causal connection. Concurrently, a unidirectional causal relationship exists between CO2 and DC, MC and FDI, and MC and DC, respectively.
36	Demissew, Beyene and	23 East African Countries	Pooled Mean Group (PMG)	1990–2013	Findings rejects the EKC hypothesis in the long-run but accepted it the short-run

	Kotosz (2019)		approach		estimation
37	Li and Ouyang (2019)	China	Autoregressive Distributed Lag (ARDL) Approach	1978 - 2015	Findings indicate that financial openness measured by net FDI inflows significantly reduces CO2 emission intensity in both the short-term and the long-term, whereas the effects of both financial scale and financial efficiency are limited and insignificant. improving human capital first decreases CO2 emission intensity (before 1992), then increases it in the short-run (after 1992), and, finally, lessens it in the long-run. Furthermore, raising per capita income can also significantly lower CO2 emission intensity in the long-run.
38	Emir and Bekun (2019)	Romania	The autoregressive distributive lag (ARDL) model and Granger Causality test	1990 – 2014	The results indicate a unidirectional causal relationship between the use of renewable energy and economic growth, but a feedback causal relationship between energy intensity and economic growth. Furthermore, the result supports the idea of energy-led expansion.
39	Adzawla, Sawaneh and Yusuf (2019)	Selected SSA	Ordinary Least Squares (OLS) VAR	1970 – 2012	Findings did not show evidence that there is a turning point as posited by the EKC hypothesis The OLS and VAR indicate an Inverted N-shaped relationship and an inverted N-shaped relationship

					respectively.
40	Acheampong, Adams & Boateng (2019)	46 SSA countries	Fixed and Random Effect Regression	1980 - 2015	Results back up the EKC theory. The finding also demonstrates that although trade openness promotes environmental deterioration, FDI and population growth lower carbon emissions.
41	Isiksal, Samour and Resatoglu (2019)	Turkey	Autoregressive Distributed Lag (ARDL) bounds test and the Granger causality test within the vector error correction model (VECM)	1980 - 2014	Findings indicate that real interest rate negatively effects CO2 emissions. This impact is also supported through energy, income, and FDI channels
42	Egbetokun, et al., (2019)	Nigeria	Auto Regressive Distribution Lag (ARDL)	1970 - 2017	Results show that CO2 and SPM have an EKC. This suggests that with coordinated efforts, Nigeria may pursue the goal of green growth. There was no discernible impact of any environmental contamination measures on economic development.
43	Zaidi, Zafar, Shabaz and Hou (2019)	Asian Pacific Economic Cooperation countries	Pooled Ordinary Least squares (OLS)	1990 - 2016	Findings reveal that financial development significantly reduced carbon emissions.
44	Majeed and Maria (2019)	131 countries	Pooled Ordinary Least squares (OLS), Fixed Effects Model, Random Effects Model and system generalized method of moments (GMM)	1971 - 2017	The results show that all financial development indicators—banks' domestic credit to the private sector, the financial sector's domestic credit to the private sector, and domestic credit to the private sector—significantly contribute to

					enhancing environmental quality by lowering ecological footprints. On the other hand, by expanding the ecological footprint, energy consumption, FDI, and GDP per capita degrade environmental quality. The "pollution haven hypothesis" for the world economy is also supported by the study.
45	Dasuki and Olubusoye (2020)	43 African countries	ARDL Approach, Mean Group (MG), and the Pooled Mean Group (PMG)	1980 – 2016	Only 21% of the sample's findings supported the EKC hypothesis, whereas 70% of the sample's nations rejected 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.
46	Shahbaz, Haouas , Sohag & Ozturk (2020)	United Arab Emirates	Pooled Ordinary Least squares (OLS) and Toda-Yamamoto causality test	1975QI-2014QIV	Findings show that the development of the financial system increases CO2 emissions. Economic growth was found to be positively linked to environmental degradation while globalization was positively linked with carbon emissions. The relationship between financial development and CO2 emissions is U-shaped and inverted N-shaped. Further, financial development leads to environmental degradation, and environmental degradation in turn leads to

					financial development in the Granger sense.
47	Bah,Abdulwaki & Azam (2020)	10 Middle-Income countries in SSA	Ordinary Least Squares (OLS)	1971–2012	Results validated the existence 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.
48	Ajayi and Ogunrilola (2020)	Nigeria	Autoregressive Distributed Lag Bounds Testing Approach	1960-2017	Findings validate the EKC hypothesis in Nigeria in the long-run.
49	Longe, Bolaji, Soyemi, & Adebayo (2020)	Nigeria	Vector Error Correction Model (VECM) approach.	1971 - 2017	The results showed that whereas energy consumption and the gross domestic product (GDP) had a positive long-term impact on carbon emissions, financial development had a negative short-term impact and a positive long-term impact on carbon emissions. The results of the causality test showed that carbon emissions are caused by production, financial development, and energy consumption all together. However, there was no discernible causal relationship between financial development and carbon emissions.

50	Lestari, Effendi and Priyono (2020)	Asian emerging markets	Fully Modified OLS (FMOLS) and Dynamic Ordinary Least Square (DOLS)	1980 – 2018 for banking model, and 1996 – 2018 for financial sector model (banking sector and capital market sector).	Finding revealed that in Asian emerging markets there is positively long-term relationship between financial developments from banking model with environmental degradation. However, there was no long-term relationship between financial developments from financial sector model with environmental degradation.
51	Ouédraogo, Peng, Chen, Hashmi and Sal (2021)	11 African oil-producing countries	mean group (AMG)	1980 – 2014	Findings reveal that oil resources abundance degrades the environmental quality in Angola while abating CO2 emissions in Algeria, Gabon, Morocco, and Nigeria. Contrarily, energy consumption escalates pollution in the Congo Democratic Republic, Côte d'Ivoire, Gabon, Morocco, and Tunisia. The outcome supports the EKC hypothesis only in Cameroon, Côte d'Ivoire, and Nigeria while exhibiting a U-shaped curve in Algeria and Morocco. Causality analysis unveils that oil resources Granger cause energy consumption, suggesting the balance between renewable and non-renewable energy sources
52	Alabi, Ojuolape & Yaqoob (2021)	Sri Lanka	Autoregressive Distributed Lag Bounds Testing Approach	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 CO2 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.
53	Musa, Chindo and Maijama'a (2021)	Nigeria	Autoregressive Distributed Lag Bounds Testing Approach and Granger Causality Test	1981 - 2019	indicated that financial development and income level significantly negatively impact the CO2 emissions. The Granger causality result revealed bidirectional causality from financial development to CO2 emissions, income level to CO2 emissions, and financial development to income level.
54	Hasan, Oudat, Alsmadi, Nurfahasdi & Ali (2021)	Bahrain	Vector Error Correction Model (VECM)	1980–2018	Findings indicate that only financial development has an impact on carbon emission in the short term. For the Granger causality test, only financial development and population led positive impact on CO2, while carbon emission does not Granger-cause financial development and population. Also, the study findings did not support the hypothesis of the environmental Kuznets curve (EKC).
55	Khuky (2021).	Bangladesh	Dynamic Ordinary Least Squares (DOLS) and Fully Modified OLS (FMOLS)	1983 - 2019	The results showed that whereas energy consumption and the gross domestic product (GDP) had a positive long-term impact on carbon emissions, financial

			approaches		development had a negative short-term impact and a positive long-term impact on carbon emissions. The results of the causality test showed that carbon emissions are caused by production, financial development, and energy consumption all together. However, there was no discernible causal relationship between financial development and carbon emissions.
56	Tahir, luni, Majeed and Zafar (2021)	South Asian Countries	Dynamic Ordinary Least Squares (DOLS)	1990 - 2014	Findings show that financial development contributed to carbon emissions.
57	Nyarkoa and kaya (2021)	36 middle-income countries	Pooled Ordinary Least Squares, Fixed Effects Model, Random-Effects Model, and Quantile Regressions	1996 - 2012	Findings from the random-effects model reveal that financial development mostly has a negative relationship with environmental degradation when climate change vulnerability is used as an indicator. However, the quantile regression model generated mostly insignificant and inconsistent results. Lastly, we found evidence of both the N-shaped and inverted N-shaped EKC when using both random-effects model and quantile regressions, indicating that the original inverted U-shaped EKC does not hold in the long run.
58	Khan, Khan and Muhammad	128 countries	seemingly unrelated regression and	1990 - 2017	Findings show that financial development positively

	(2021)		GMM		impacted carbon emissions
59	Lv and Li (2021)	97 Countries	Ordinary Least Squares	2000 2014	Results show that the impact of financial development on carbon emissions is adverse.
60	Shahbaz, Destek, Dong and Jiao (2021)	G-7 Countries (i.e. Canada, France, Germany, Italy, Japan, the United Kingdom (UK), and the United State (US))	Pooled Ordinary Least Squares and bootstrap time-varying co-integration (TVC) and bootstrap rolling window estimation	1870 - 2014	Findings reveal that the impact of financial development on CO2 emissions over a long history is M-shaped in Canada, Japan, and the US; inverted N-shaped in France, Italy, and the UK; and inverted M-shaped (W-shaped) in Germany.
61	Ibrahim and Vo (2021)	27 selected industrialized countries	System Generalized Method of Moments (GMM) and Granger causality test	1991–2014	Findings reveal that, while innovation lowers environmental pollution, beyond a certain threshold level, higher innovation exacerbates environmental degradation. Furthermore, while improved financial development increases pollution, higher innovation dampens the environmental quality–reducing effect of finance. Findings from the panel causality tests also reveal a feedback causal linkage between innovation and ecological footprint, and a one-way causality from CO2 emissions to innovations. However, irrespective of the indicator of environmental pollution, financial development and pollution evolve independently, albeit differences at the country

					levels.
62	Shogbande and Ogbeifun (2021)	Organization for Economic Cooperation and Development (OECD) countries	System Generalized Method of Moments (GMM)	1980 – 2019	Findings revealed that financial development index and energy efficiency reduce carbon emissions and promote sustainability in the OECD countries
63	Aljadani (2022)	Saudi Arabia	Autoregressive Distributed Lag (ARDL)	1970 - 2016	Findings show that financial development and technology have a negative and significant impact on environmental degradation. The technology effects of financial development have an unfortunate effect on environmental mitigation.
64	Habiba and Xinbang (2022)	Selected Developed and Emerging Countries	System GMM	2000 - 2018	Findings reveal that the overall financial market development and its sub-indices (FM-access, FM-depth, and FM-efficiency) reduce CO2 emissions in developed and emerging countries. The results further show that the overall financial institution development and its sub-indices such as FI-access, FI-depth, and FI-efficiency foster the environment quality in developed economies, while these indices impede the environmental quality in emerging economies. The usage of renewable energy is found to be a viable solution to mitigate the CO2 emissions in both groups of countries.

Source: Author's Compilation, (2024).

2.7 Research Gap in the Empirical Literature

From the survey of extant empirical literature on the influence of financial development and economic growth on environmental degradation the following gaps in knowledge became evident. In general, there is no consensus on the effect of financial development and economic growth on environmental degradation. For instance, researchers such as Tamazian *et al*., (2009); Mahalik and Mallick, (2014); Sehrawat *et al*., (2015); and Gill *et al*., (2019) among others, have investigated the relationship between financial development and environmental degradation. They conclude that financial development reduces environmental degradation. On the other hand, the studies of Aslan *et al*., 2014; Al-Mulali *et al*., 2015; Shahbaz *et al*., 2016; Le *et al*., 2020 have found that the financial development increases environmental degradation.

Regarding the relationship between economic growth and environment degradation, results from prior studies are also inconclusive. Some studies confirmed the EKC hypothesis with an inverted U-shaped relationship between economic growth and environmental degradation (Shahbaz *et al.,* 2012; Tiwari *et al.*, 2013; Alam *et al.*, 2016; Al-Mulali & Ozturk, 2016; Kwakwa & Adu, 2016; Sinha & Sen, 2016; Aboagye, 2017; Boopen & Vinesh, 2011; Shahbaz *et al*., 2018; Sinha & Shahbaz, 2018; Dong *et al*., 2018). In contrast, other studies reported non-existence of EKC, arguing that increase economic growth reduces environmental quality (Nassani *et al*., 2017; Dogan & Ozturk, 2017; Pal & Mitra, 2017; Sinha *et al.*, 2017; Balsalobre-Lorente *et al.*, 2018; Onafowora & Owoye, 2014).

The mixed results could be attributed to the heterogonous financial structure of the studied countries; methodological flaws and omitted variables bias could also be the reason for the conflicting results; divergent climate condition and pattern of carbon emissions of the country or

countries under investigation could also account for the mixed results; data used and the differences in some features characterizing the countries studied could also be the reason for the differences in results. 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 environmental consequences of improved financial system and economic growth in the context of Sub-Saharan Africa.

Furthermore, unlike majority of the previous studies (Bekhet *et al*., 2017; Maji *et al*., 2017; Zakaria and Bibi, 2019 among others), this study utilized both carbon dioxide (CO_2) emission and ecological footprint as measure or indicator of environmental degradation. A major flaw of the majority of previous studies on this subject matter particularly, those carried out in Sub-Saharan African countries, is that they rely on CO_2 emissions as the only indicator of environmental degradation, CO_2 emissions is not a complete measure of environmental degradation. However, CO_2 emissions are just an aspect of environmental degradation caused by large scale energy consumption (Al-Mulali *et al*., 2015).

To the best of the researcher knowledge, this study is one of the few studies in the Sub-Saharan Africa context that examine the effect of financial development and economic growth on environment degradation using both CO_2 emission and ecological footprint measures. Employing ecological footprint as an additional measure of the environment, gives a better knowledge of environmental deterioration since it is a more complete measure and trustworthy indication of environmental degradation and will no doubt make the results more robust and provide a strong basis for comparative analysis between the two measures, which improves the robustness. Also, another key issue with most of the previous studies is the estimation technique utilized for the panel data analysis. Thus, studies employing estimation techniques like Random or Fixed effect

methods are confronted with the problem of parameter heterogeneity which can produce inconsistent and potentially very misleading estimates of the average values of the parameters in panel data models. The Mean Group (MG) and the Pooled Mean Group (PMG) method developed by Pesaran, Shin, and Smith (1999) is appropriate for this study as it allows for a higher degree of parameter heterogeneity in regressions than the other estimators.

The PMG estimator provides a way of at least partly overcoming the problem of parameter heterogeneity by assuming homogeneity of the long run coefficients while allowing the short run coefficients and error variances to differ across countries. Hence, the PMG estimator considers country-specific effects as usual but also allows the short run growth responses of each country to vary, imposing only common long run relationships. The MG estimator allows for heterogeneity of all coefficients, intercepts and slopes, by estimating a separate equation for each country while the coefficients for the whole panel are computed as un-weighted averages of the individual coefficients. Hence, 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 relationship amongst the variables and contributes to extant literatures new empirical evidence on the effect of financial development and economic growth on environmental degradation in Sub-Saharan African countries.

While, a number of studies have been carried out to analyse the effect of financial development on environmental degradation (Ozturk and Acaravci, 2013; Ziaei, 2015; Majeed and Mazhar, 2019 Shogbande and Ogbeifun, 2021 among others) as well as effect of economic growth on environmental degradation (Narayan & Narayan, 2010; Al-Mulali & Ozturk, 2016; Sinha & Sudipta, 2016; Emir & Bekun, 2019; Olubusoye & dasuki, 2020 among others), it was observed from the survey of extant literature that few studies (Tamazia *et al*., 2009; Kwakwa *et al*., 2018)

have examine the joint effect of financial development and economic growth on environmental degradation. The joint effect of financial development and economic growth on environmental degradation is largely unexplored in Sub-Sahara African context. Hence, this study will develop a model that accounts for the joint effect of financial development and economic growth on environmental degradation in sub-Saharan Africa countries.

Also, majority of extant literature examining the EKC hypothesis applied the polynomial regression models. The polynomial specification contains as independent variables such as GDP, the square of GDP and in some cases GDP raise to the third degree which enables detection of linear, quadratic and cubic relationships respectively (Gao & Zhang, 2014; Alege, Adeyemi & Ogundipe, 2016; Ketenci, 2018; Egbetokun, Osabuohien, Akinbobola, Onanuga, Gershon & Okafor, 2019 among others). High multi-collinearity among the variables has been identified to accommodate this approach, which will lead to spurious results, thus, inferences drawn from spurious results will be misleading in policymaking with great implications. The present study will fill the gap, by using a non-polynomial regression model to investigate the presence of an inverted U relationship also known as the environmental Kuznets curve (EKC) in selected sub-Saharan Africa countries.

The present study is an attempt to fill or bridge these gaps in knowledge by empirically examining the effect of financial development and economic growth on environmental degradation in selected sub-Saharan Africa countries.

2.8 Research 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 environmental degradation. The schematic representation of the relationships between the independent variables and the dependent variable is shown in Figure 1.

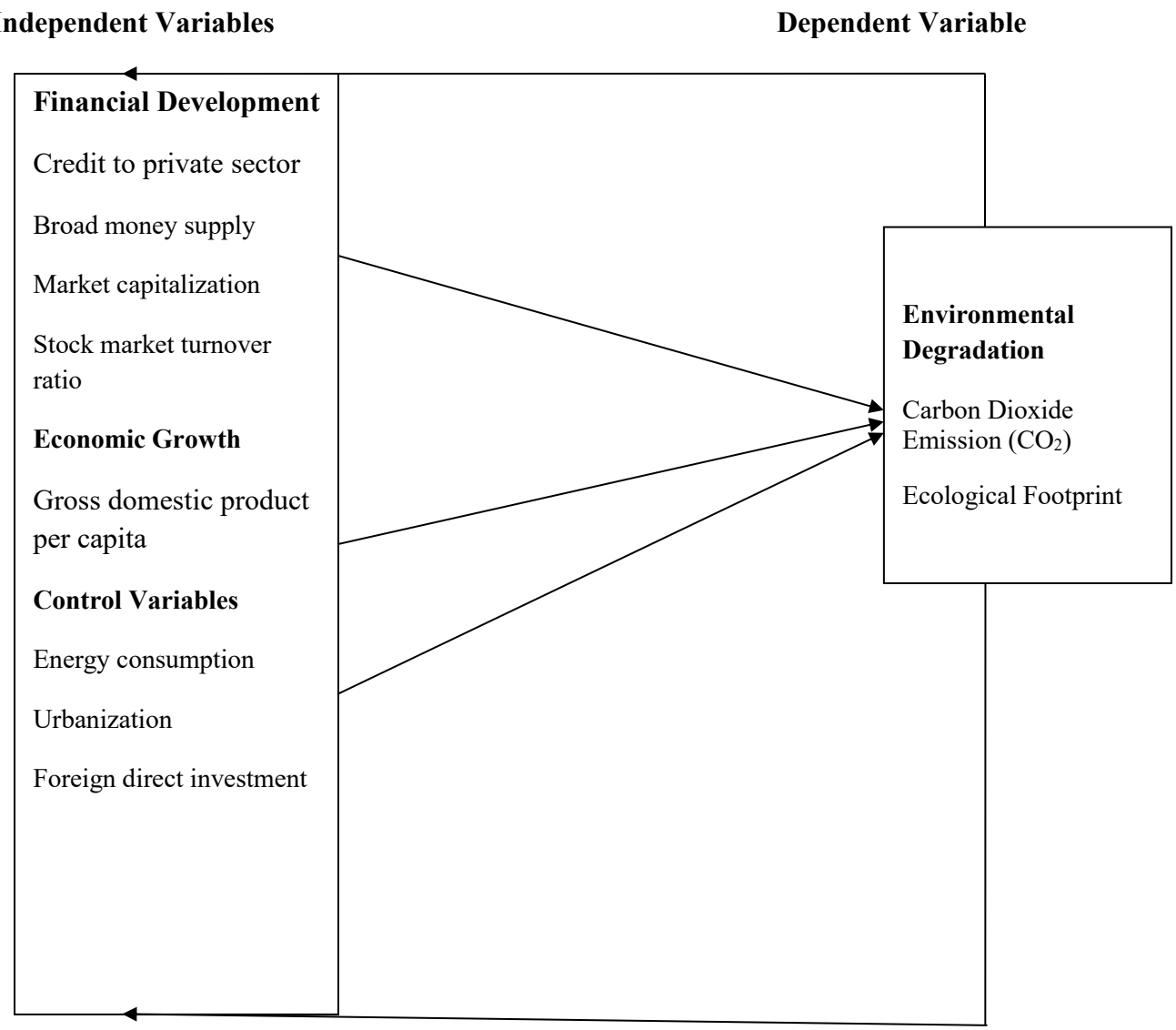


Figure 2.1: Conceptual Framework depicting the relationship among the variables of interest

Source: Researcher's Design, 2024.

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

This study will employ a longitudinal research design within a panel data research framework. This is because financial development, economic growth and its relationship with environmental degradation in Sub-Saharan African countries have been observed over the same fixed period of time. 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

The population of the study comprises all the forty eight (48) countries that make up the Sub-Saharan African region according to World Bank (2021).

3.4 Sampling Technique and Sample Size

A convenient sample of seven (7) countries (Cote d'ivoire, Ghana, Kenya, Mauritius, Namibia, Nigeria and South Africa) was included in the study. This sample was selected by data filtering technique based on the following three criteria: availability of data for the period of study (that is, 1993 – 2021); (ii) they represent some of the most developed financial system and most active economies in the Sub-Saharan African region and (iii) regionalization was considered in the country selection and inclusion.

3.5 Sources of Data

The data for this study will be sourced from the World Bank's World Development Indicators (WDI) of 2021 and the Global Footprint Network (2021). The data will be collected from 1993 to 2021.

3.6 Theoretical Framework

Environmental Kuznets Curve (EKC) theory provides the theoretical underpinning for this study. The theory makes the case that early economic expansion and development are linked to significant environmental deterioration. Environmental degradation, or the pace at which carbon dioxide emissions occur, decreases at a certain point of growth and development. The link between wealth and environmental deterioration, of which carbon dioxide emissions are a major factor, eventually takes the form of an inverted U.

The common reasons for such a situation as given by Grossman and Krueger (1995), Panayotou (1997) and Stern (2003) are the scale effect (an expansion in economic activities that relies on energy will increase carbon dioxide emission and deteriorates the environment); composition effect (a change in output composition from agrarian to manufacturing will initially increase carbon dioxide emission; and then later to service activities which will reduce pollution); and abatement effect of economic growth and development (once economic development has been attained individuals and policymakers become more environmentally conscious and thus put policies in place to reduce carbon dioxide emission). Copeland & Taylor (2004) also attribute the existence of the EKC hypothesis to the source of economic growth. An economy whose initial growth is powered by capital accumulation but has human capital acquisition as the source of its advanced growth will witness this inverted U relationship between income and environment.

The EKC hypothesis not only explores the impact of economic growth on environmental degradation but also the impact of other indicators of economic development and financial development on environmental degradation. The influence of financial development on environmental deterioration has been noted in the literature (Destek & Sarkodie, 2019; Katircioglu & Katircioglu, 2018; Sarkodie & Strezov, 2019; Zhang, 2011; Zhang & Zhang, 2018). Zhang (2011) emphasized the importance of a well-developed institution in mitigating environmental quality. Through research and development, financial development promotes environmental quality by attracting and bringing more environmentally friendly ideas to market. It may also make it easier to invest in renewable energies. Investment in renewable energy, example, is increasing, which is more environmentally friendly and helps to lessen the ecological impact.

Financial development on the other hand, can boost economic efficiency by minimizing capital risk and financial costs. In addition, through extending Foreign Direct Investment (FDI) inflows, stock market operations, and banking operations, financial system development may boost Research and Development (R & D) and investment in clean technologies. Financial system development, on the other hand, contributes to environmental damage by encouraging and enabling the use of credit to buy mechanical machinery, electrical equipment, vehicles, and residences. These facilities assist investors in broadening their company scopes and establishing new machinery and factories, which increases carbon emissions in the environment and deteriorates environmental quality (Zhang & Zhang, 2018).

Concerns about the impacts of economic activities on the environment can be traced back to the 19th century when Reverend Thomas Malthus condemned poor relief programmes (Raymond 2004). He argued that poor relief programmes are detrimental to the environment and a threat to

man's ability to feed future generations. Since then, the debate about the relationship between environmental quality and development has been divided between Malthus' 'limit to grow' hypothesis and those that reason that economic growth is the key to environmental and human prosperity (Raymond 2004).

In the process of identifying factors that determine the degree of environmental impact during different stages of the development process, the IPAT equation was devised by Ehrlich & Holdren (1970) and Commoner (1972). The IPAT equation, which is represented by Equation 3.1, is expected to measure an economy's path towards sustainability. The environmental impact, represented by *I*, depends upon the levels of population (*P*), affluence (*A*) and technology (*T*). A growing population is implied to lead to higher pressure on the environment, a higher level of affluence would end up in a rising generation of wastes and pollution, and a level of technology can either reduce the degree of environmental impact or expand it (UNCTAD, 2011).

$$I = P \times A \times T \quad \ldots\ldots (3.1)$$

The IPAT equation has been altered in various ways. Grunewald & Martinez-Zarzoso (2009) posited that the main deficiency of the IPAT equation is that it cannot explain the non-proportional effects of the variables on the right-hand side of Equation 3.1 because it is an accounting equation. To correct this, Dietz & Rosa (1997) reformulated this equation into a stochastic equation (a more elaborate approach to IPAT) called Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT).

$$I_i = \alpha P_i^{\beta} A_i^{y} T_i^{\delta} \varepsilon_i \quad \ldots\ldots (3.2)$$

The term I is the environmental impact for country i, α is the constant term, P is the population of country i with coefficient β, A is affluence in country i with coefficient γ, T is technology in country i with coefficient δ and ε is the error term. In Equation 3.2, Dietz & Rosa (1997) stopped at T by making it an error term and not to determine the influence of technology on environmental impact. York, Rosa & Dietz (2003) expanded STIRPAT by adding ε as the error term and allowing T to measure the influence of technology (Grunewald & Martinez-Zarzoso 2009).

Some academics think that the wealth element is the key indication for solving environmental issues. They contend that environmental deterioration grows with economic growth and per capita income, but that environmental quality improves after a particular income, or level of prosperity, is attained.This relationship between economic growth and the environment is called the Environmental Kuznets Curve (EKC) hypothesis (UNCTAD, 2012). The theoretical model to explain the EKC hypothesis was developed by Andreoni & Levinson (2001). Andreoni & Levinson (2001) explained the EKC from a consumer point of view and assume increasing returns to pollution abatement.

To keep things simple, we'll suppose that there is just one individual in an economy. In this sense, our approach may be considered Pareto efficient. Assume that the consumption of one private good, C, and one harmful good, P, known as pollution, provide the single agent with utility (U). In this way, preferences may be expressed as follows: the general function of an agent's pollution and consumption is its utility:

$$U = U(C, P) \quad \text{..... (3.3)}$$

Obtaining partial differentiation of C and P from Equation 3.3, where $U_c > 0$ $\left[or\left(\frac{\delta U}{\delta C}\right) > 0\right]$ and $U_p < 0$ $\left[or\left(\frac{\delta U}{\delta C}\right) < 0\right]$, and utility is quasi-concave in C and – P.

Assume also that pollution is a consequence of consumption and that our customer may mitigate pollution by allocating resources (shown by E) to either clean up the pollution or, conversely, avoid it altogether. Thus, pollution is a function of consumption that is positive and of environmental effort that is negative (i.e., E):

$P = P(C, E)$ ..... (3.4)

Where $P_C > 0$ and $P_E < 0$

Suppose C and E are the recipients of a restricted income (Y). The resource limitation we have when we normalise C and E to 1 is as follows:

$Y = C + E$ ..... (3.5)

Thus, in C and P, we may have a new utility function that is additive and linear:

$U = C - zP$ ..... (3.6)

$P = C - C^{\alpha}E^{\beta}$ ..... (3.7)

Gross pollution prior to abatement is the first term (C) in Equation 3.7 and it is directly related to consumption. The abatement is represented by the second term, C^α E^β. According to Equation 3.6, resources used for environmental efforts reduce pollution using a conventional concave production function, while pollution is caused by consumption one for one.

Standard Cobb-Douglas solutions exist for consumption and environmental effort if z=1 in Equation 3.6. Subject to the constraint in Equation 3.8, the consumer can maximise utility by selecting the best consumption and environmental effort in accordance with the objective function (i.e., by substituting Equation 3.7 into 3.6 to produce the objective function):

$$U = C^{\alpha}E^{\beta}\ subject\ Y = C + E \quad \ldots\ldots\ldots\

Equation 3.7 is created by changing the ideal consumption and environmental activities from Equation 3.9.

$$P = \left(\frac{\alpha}{\alpha+\beta}\right) Y, \ -\left(\frac{\alpha}{\alpha+\beta}\right)^{\alpha}\left(\frac{\beta}{\alpha+\beta}\right)^{\beta} Y^{\alpha+\beta} \quad \text{(3.10)}$$

We consider the first and second derivatives of Equation 3.10 with regard to Y to observe how wealth affects environmental degradation:

$$\frac{\partial P}{\partial Y} = \left(\frac{\alpha}{\alpha+\beta}\right) - (\alpha+\beta)[\left(\frac{\alpha}{\alpha+\beta}\right)^{\alpha}\left(\frac{\beta}{\alpha+\beta}\right)^{\beta} Y^{\alpha+\beta-1} \quad \text{(3.11)}$$

$$\frac{\partial^2 P}{\partial Y^2} = -(\alpha+\beta-1)(\alpha+\beta)[\left(\frac{\alpha}{\alpha+\beta}\right)^{\alpha}\left(\frac{\beta}{\alpha+\beta}\right)^{\beta} Y^{\alpha+\beta-2} \quad \text{(3.12)}$$

The first derivative is found in equation 3.11, while the second derivative is found in equation 3.12.

Optimisation states that the second derivative of a maximisation function must be less than zero. Equation 3.8 states that the consumer's goal is to maximise utility, which is why (∂^2 P⁄〖∂Y〗 ^2 <0. The equation 3.12 illustrates this. Since z cannot equal one and the EKC is concave, or inverse U-shaped, as illustrated in Figure 3.1(C), α+β>1. This indicates that there are growing returns to scale in pollution abatement.

If we take the natural log of the STIRPAT equation (Equation 3.2) and add more explanatory variables:

$$lnI = \alpha_0 + \beta lnP_i + \gamma lnA_i + \delta lnT_i + \mu_i \quad \text{(3.13)}$$

Where $\alpha_0 = ln\alpha$ and $\mu_i = ln\varepsilon_i$. The STIRPAT equation leads to a log-linear model (see Dietz and Rosa 1997). This model is the relationships that are explored in this research and it is the recently proposed income elasticity approach by Narayan & Narayan (2010) to investigate the presence of an inverted U relationship also known as the environmental Kuznets curve (EKC). The criteria to investigate the presence of EKC proposed by Narayan & Narayan (2010) is that when the long-run income elasticity (GDP) is less than the short-run income elasticity then the relationship is consistent with the EKC hypothesis. Alternatively, if the short-run income elasticity is positive and statistically significant and the long-run income elasticity is negative and statistically significant, then it suggests the presence of EKC, which implies that environmental degradation (carbon emissions and ecological footprint) have increased and reduced over time as income (economic growth) in the country increases.

Instead of linear modelling, many studies model the EKC by analyzing the relationship between some measure of environmental degradation, *E*, and real per capita income, *Y*, with a vector of other explanatory variables, *Z* (for instance, financial development, energy consumption, urbanization, foreign direct investment, etc.) (Agras & Chapman, 1999). Such model is expressed as:

$$E = \beta_0 + \beta_1 Y + \beta_2 Y^2 + \beta_k Z + \varepsilon \ldots\ldots\ldots\

Where $lnE = lnI,\ lnA_i = lnY$, and lnP_i and $lnT_i = lnZ$. Equation 3.15 becomes a log-quadratic model (Agras & Chapman 1999).

The version of EKC presented by Moomaw & Unruh (1997) and Carvalho and Almeida (2010) can be presented as:

$$E = \beta_0 + \beta_1 Y + \beta_2 Y^2 + \beta_3 Y^3 + \varepsilon \quad (3.16)$$

If other variables are added to Equation 3.17 (see Onafowora & Owoye 2013):

$$E = \beta_0 + \beta_1 Y + \beta_2 Y^2 + \beta_3 Y^3 + \beta_k Z + \varepsilon \quad (3.17)$$

The log-cubic model in Equation 3.18 may be generated by taking the natural log of Equation 3.17 and combining it with Equation 3.13.

$$lnE = \beta_0 + \beta_1 lnY + \beta_2 lnY^2 + \beta_3 lnY^3 + \beta_k lnZ + \varepsilon \quad (3.18)$$

The thread that runs through all these is that this study estimates the log-linear (Equation 3.13), relationship between environmental degradation (per capita emissions of CO_2 and per capita ecological footprint) and per capita income while considering other variables that possess the characteristics of cleanup or increase in emissions. The log-linear, log-quadratic and log-cubic models will not be employed in this study because high multi-collinearity among the variables has been identified to accommodate this approach, which will lead to spurious results. This is confirmed by Narayan & Narayan (2010).

3.7 Model Specification

The EKC hypothesis, which holds that environmental deterioration is caused by economic growth, will serve as the foundation for the models used in this investigation. The study will use

two indicators (Carbon emission (metric tons per capita (kt) and Ecological footprint per capita (hectares (gha)) to proxy environmental degradation. Also, we will employ six proxies for financial system development these are credit to private sector, liquid liability ratio, interest rate spread to gross domestic product, market capitalization to gross domestic product, stock market turnover ratio and stock market total value traded to gross domestic product. The model also involved having data on the gross domestic product per capita in a country per year as the proxy for economic growth.

In order to investigate the effects of financial development and economic growth on environmental degradation in Sub-Saharan African countries, the models of Jiang and Ma (2019) and Dasuki & Olubusoye (2020) were adopted and modified in terms of variables included to proxy financial development, economic growth, environmental degradation as well as the control variables introduced to account for other factors that have been found to influence environmental degradation. The Econometric model of Jiang and Ma (2019) and Dasuki & Olubusoye (2020) are therefore seen below; Jiang & Ma (2019) model the effect of financial development on environmental degradation as follows:

$$CE_{it} = \alpha + \beta_0 CE_{it-1} + \beta_1 FD_{it} + \gamma Control_{it} + \mu_i + \varepsilon_{it} \quad \text{..... (3.19)}$$

Where: CE_{it} represents carbon emission; CE_{it-1} represents the lag-term of carbon emissions; FD_{it} signifies the financial development; $Control_{it}$ denotes a series of control variables (trade openness, urbanization, population growth and industrial structure); β_0, β_1, and γ are the corresponding coefficients; μ_i represents the unobserved country specific effect; ε_{it} is the residual term; and i and t indicate the country and time, respectively.

Dasuki & Olubusoye (2020) Model the effect of economic growth on environmental degradation as follows:

$lCO2_{i,t} = \beta_0 + \beta_i lGDP_{I,T} + \beta_2 Econs_{i,t} + \varepsilon_{i,t}$ ……..... (3.20)

T=1,..., T; i=1,..., N

Where: $lGDP_{I,T}$, $lEcons_{i,t}$ and $lCo2_{i,t}$ represent the natural logarithm of real GDP, energy consumption and carbon emissions respectively and ε is the error term.

Based on the fact that in this study we will employ different financial system development proxies and we did not include index of financial development in our model; in terms of control variables this study did not include industrial structure and population growth in our model, the above models are therefore modified to determine the link between financial system development, economic growth and environmental degradation in selected Sub-Saharan African Countries.

In the specification of the models for this study, six (6) panel regression models are specified. The first two models, that is, model (3.23) and (3.24) examine the relationship between financial development and environmental degradation for both the long-run and the short-run, while the second set of models that is model (3.27) and (3.28) examines the relationship between economic growth and environmental degradation for both long-run and the short-run. The third set of models that is model (3.31) and (3.32) examines the joint effect of financial development and economic growth on environmental degradation for both the long-run and short-run in the selected Sub-Saharan Africa countries.

Model I: Financial System Development and Environmental Degradation Model

The functional form of the model is stated thus:

$$CO2 = f(CPS, LLR, MKC, SMT, ENC, URB, FDI, SER) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.21)$$

$$EFP = f(CPS, LLR, MKC, SMT, ENC, URB, FDI, SER) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.22)$$

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:

$$\begin{aligned}\Delta lnCO2_{it} = {} & \beta_0 + \beta_1 lnCO2_{it} + \beta_2 lnCPS_{it} + \beta_3 lnLLR_{it} + \beta_4 lnMKC_{it} + \beta_5 lnSMT_{it} + \\ & + \beta_6 lnURB_{it} + \beta_7 lnURB_{it} + \beta_8 lnFDI_{it} + \beta_9 lnSER_{it} \\ & + \sum_{i=1}^{J} \alpha_1 \Delta lnCO2_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnCPS_{it-1} + \sum_{i=1}^{p} \alpha_3 lnLLR_{it-1} \\ & + \sum_{i=1}^{r} \alpha_4 \Delta lnMKC_{it-1} + \sum_{i=1}^{s} \alpha_5 \Delta lnSMT_{it-1} + \sum_{i=1}^{v} \alpha_6 \Delta lnENC_{it-1} \\ & + \sum_{i=1}^{w} \alpha_7 \Delta lnURB_{it-1} + \sum_{i=1}^{x} \alpha_8 \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \beta_9 lnSER_{it} + \varepsilon_{it} \ldots (3.23)\end{aligned}$$

$$\begin{aligned}\Delta lnEFP_{it} = {} & \beta_0 + \beta_1 lnEFP_{it-1} + \beta_2 lnCPS_{it} + \beta_3 lnLLR_{it} ++ \beta_4 lnMKC_{it} + \beta_5 lnSMT_{it} \\ & + \beta_6 lnENC_{it} + \beta_7 lnURB_{it} + \beta_8 lnFDI_{it} + \beta_9 lnSER_{it} \\ & + \sum_{i=1}^{J} \alpha_1 \Delta lnEFP_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnCPS_{it-1} + \sum_{i=1}^{p} \alpha_3 lnLLR_{it-1} \\ & + \sum_{i=1}^{r} \alpha_4 \Delta lnMKC_{it-1} + \sum_{i=1}^{s} \alpha_5 \Delta lnSMT_{it-1} + \sum_{i=1}^{v} \alpha_6 \Delta lnENC_{it-1} + \sum_{i=1}^{w} \alpha_7 \Delta lnURB_{it-1} \\ & + \sum_{i=1}^{x} \alpha_8 \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \beta_9 lnSER_{it} + \varepsilon_{it} \ldots (3.24)\end{aligned}$$

Model II: Economic Growth and Environmental Degradation Model

The functional form of the model is stated thus:

$$CO2 = f(GDPPC, ENC, URB, FDI, SER) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\

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:

$$\Delta lnCO2_{it} = \beta_0 + \beta_1 lnCO2_{it-1} + \beta_2 lnGDPPC_{it} + \beta_3 lnENC_{it} + \beta_4 lnURB_{it} + \beta_5 lnFDI_{it} + \beta_6 lnSER_{it} + \sum_{i=1}^{J} \alpha_1 \Delta lnCO2_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnGDPPC_{it-1} + \sum_{i=1}^{p} \alpha_3 \Delta lnENC_{it-1} + \sum_{i=1}^{q} \alpha_4 \Delta lnURB_{it-1} + \sum_{i=1}^{r} \alpha_5 \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \beta_6 \, lnSER_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.27)$$

$$\Delta lnEFP_{it} = \beta_0 + \beta_1 lnEFP_{it-1} + \beta_2 lnGDPPC_{it} + \beta_3 lnENC_{it} + \beta_4 lnURB_{it} + \beta_5 lnFDI_{it} + \beta_6 lnSER_{it} + \sum_{i=1}^{J} \alpha_1 \Delta lnEFP_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnGDPPC_{it-1} + \sum_{i=1}^{p} \alpha_3 \Delta lnENC_{it-1} + \sum_{i=1}^{q} \alpha_4 \Delta lnURB_{it-1} + \sum_{i=1}^{r} \alpha_5 \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \beta_6 \, lnSER_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.28)$$

Model III: Financial System Development, Economic Growth and Environmental Degradation Model

The functional form of the model is stated thus:

$$CO2 = f(CPS, LLR, IRS, MKC, SMT, STVT, ENC, URB, FDI, SER) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.29)$$

$$EFP = f(CPS, LLR, IRS, MKC, SMT, STVT, ENC, URB, FDI, SER) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.30)$$

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:

$$\Delta lnCO2_{it} = \beta_0 + \beta_1 lnCO2_{it-1} + \beta_2 lnCPS_{it} + \beta_3 lnLLR_{it} + \beta_4 lnMKC_{it} + \beta_5 lnSMT_{it} + \beta_6 lnGDPPC_{it} + \beta_7 lnENC_{it} + \beta_8 lnURB_{it} + \beta_9 lnFDI_{it} + \beta_{10} lnSER_{it} + \sum_{i=1}^{J} \alpha_1 \Delta lnCO2_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnCPS_{it-1} + \sum_{i=1}^{p} \alpha_3 lnLLR_{it-1} + \sum_{i=1}^{r} \alpha_4 \Delta lnMKC_{it-1} + \sum_{i=1}^{s} \alpha_5 \Delta lnSMT_{it-1} + \sum_{i=1}^{v} \alpha_6 \Delta lnGDPPC_{it-1} + \sum_{i=1}^{w} \alpha_7 \Delta lnENC_{it-1} + \sum_{i=1}^{x} \alpha_8 \Delta lnURB_{it-1} + \sum_{i=1}^{z} \alpha_9 \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \beta_{10} lnSER_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots (3.31)$$

$$\Delta lnEFP_{it} = \beta_0 + \beta_1 lnEFP_{it-1} + \beta_2 lnCPS_{it} + \beta_3 lnLLR_{it} + \beta_4 lnMKC_{it} + \beta_5 lnSMT_{it} + \beta_6 lnGDPPC_{it} + \beta_7 lnENC_{it} + \beta_8 lnURB_{it} + \beta_9 lnFDI_{it} + \beta_{10} lnSER_{it} + \sum_{i=1}^{J} \alpha_1 \Delta lnEFP_{it-1} + \sum_{i=1}^{m} \alpha_2 \Delta lnCPS_{it-1} + \sum_{i=1}^{p} \alpha_3 lnLLR_{it-1} + \sum_{i=1}^{r} \alpha_4 \Delta lnMKC_{it-1} + \sum_{i=1}^{s} \alpha_5 \Delta lnSMT_{it-1} + \sum_{i=1}^{v} \alpha_6 \Delta lnGDPPC_{it-1} + \sum_{i=1}^{w} \alpha_7 \Delta lnENC_{it-1} + \sum_{i=1}^{x} \alpha_8 \Delta lnURB_{it-1} + \sum_{i=1}^{z} \alpha_9 \Delta lnFDI_{it-1} + \sum_{i=1}^{x} \beta_{10} lnSER_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.32)$$

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, q, r, s, u, v, w, x, and z; 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 and β_{10} 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 and α_{10} are respectively the short-run impacts of the these variables.

$lnCO2_{it}$ = 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).

$lnEFP_{it}$ = Ecological footprint in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnEFP_{it-1}$ = Lagged value of the ecological footprint in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnCPS_{it}$ = Credit to private sector in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnCPS_{it-1}$ = Lagged value of credit to private sector in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnLLR_{it}$ = Liquid liabilities ratio in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnLLR_{it-1}$ = Lagged value of liquid liabilities ratio in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnMKC_{it}$ = Market capitalization to gross domestic product in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnMKC_{it-1}$ = Lagged value of market capitalization to gross domestic product in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnSMT_{it}$ = Stock market turnover ratio in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnSMT_{it-1}$ = Lagged value of stock market turnover ratio in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnGDPPC_{it}$ = Gross domestic product per capita in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnGDPPC_{it-1}$ = Lagged value of gross domestic product per capita in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnENC_{it}$ = Energy consumption in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnENC_{it-1}$ = Lagged value of energy consumption in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnURB_{it}$ = Urbanization in natural logarithm form in the individual SSA countries (i) in a given period (t).

$lnURB_{it-1}$ = Lagged value of urbanization 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).

$lnSER_{it}$ = Secondary school enrolment rate in the individual SSA countries (i) in a given period (t).

$lnSER_{it-1}$ = Lagged value of secondary school enrolment rate in the individual SSA countries (i) in a given period (t).

ε_{it} = error term or stochastic variables.

The variables of this study are logarithm form to allow the coefficients to be interpreted as rate of change of variables in elasticity form. Environmental degradation (carbon dioxide emission and ecological footprint) and economic growth (gross domestic product per capita) relationship are consistent with the EKC hypothesis if the long-run income elasticity of GDPPC 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 environmental degradation (carbon dioxide emission and ecological footprint) 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 emissions 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: $\beta_1>0$, $\beta_2>0$ or <0, $\beta_3> 0$ or <0, $\beta > 0$ or <0, $\beta_5> 0$ or <0, $\beta > 0$ or <0, $\beta_7> 0$ or <0, $\beta_8>0$, $\beta_9>0$, $\beta_{10} > 0$; $\beta_1> 0$, $\beta_2>0$ or <0, $\beta_3>0$, $\beta_4>0$, $\beta_5 > 0$; $\beta_1> 0$, $\beta_2> 0$ or <0, $\beta_3> 0$ or <0, $\beta_4> 0$ or <0, $\beta_5> 0$ or <0, $\beta_6> 0$ or <0, $\beta_7> 0$ or <0, $\beta_8> 0$ or <0, $\beta_9>0$, $\beta_{10}>0$.

$\beta_0 - \beta_{10,}$ $\beta_0 - \beta_5$ and $\beta_0 - \beta_{10}$ for the six models, that is model (3.23 and 3.24), (3.31 and 3.32) and (3.31 and 3.32) are coefficients of the parameters to be estimated.

In other words, theoretically, it is expected that a period lagged CO_2 emission ($lnCO2_{it-1}$) and a period lagged ecological footprint ($lnEFP_{it-1}$) is positively related to current period's CO_2 emissions and current period ecological footprint. Financial development indicators (credit to private sector, liquid liabilities ratio, interest rate spread to gross domestic product, market capitalization to gross domestic product, stock market turnover ratio and stock market total value traded to gross domestic product) are expected to have either a negative or positive impact on the level of environmental degradation (carbon dioxide emission and ecological footprint). This is because while financial development can be detrimental to environmental quality, it can also be advantageous. A scenario is when the financial sector improves environmental quality by enabling firms to adopt cleaner and environmentally friendly techniques, and vice versa (Boutabba, 2014; Shahzada et al., 2017). For economic growth, a priori expectation is that in the

short-run, economic growth is expected to have positive impact on environmental degradation while in the long-run economic growth is expected to have negative impact on the level environmental degradation. For the control variables (energy consumption, urbanization and foreign direct investment), the a priori expectation is that a rise in energy consumption, urbanization and foreign direct investment will aggravate or increase environmental degradation.

Model IV: Granger Causality between Economic Growth and Environmental Degradation Model

In order to investigate the direction of causation between the specific variables representing environmental degradation, financial development and economic growth in Sub-Saharan Africa 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 will help to ascertain whether a uni-directional or bi-directional (feedback) relationship exists between environmental degradation and financial development as well as between environmental degradation 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 will be 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\

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 will be estimated following the second scenario above, specifically, using a multivariate panel causality technique in order to test the direction of causation between environmental degradation and financial development variables as well as between environmental degradation and economic growth variable.

3.8 Measurement of Variables

Variables	**Variable Type**	**Measurement**	***A-priori* Expectation**	**Previous Study that Utilized the Variable**
Carbon Dioxide Emission (CO2)	Dependent	Carbon emission (metric tons per capita (kt)		Alabi et al., (2021)
Ecological Footprint (EFP)	Dependent	Ecological footprint per capita (hectares (gha))		Khuky (2021)
Credit to Private Sector (CPS)	Independent	Measured as domestic credit to private sector/GDP, i.e., is the finance provided to the private sector by financial institutions divided by GDP.	(-) (+)	Hasan et al., (2021)
Liquid Liabilities Ratio (LLR)	Independent	The liquid liabilities ratio is calculated as M2, i.e., broad money supply (currency plus demand and interest bearing liabilities of bank and non-bank financial	(-) (+)	Nyarkoa & Kaya (2021)

		intermediaries) divided by GDP.		
Interest Rate Spread (IRS)	Independent`	IRS is the difference between the average loan rate and the average deposit rate that is quoted and charged by banks.	(-) (+)	Ziaei (2018)
Market Capitalization (MKC)	Independent	The stock market capitalization is the worth of listed shares and bonds divided by GDP.	(-) (+)	Hamdan et al., (2018)
Stock Market Turnover Ratio (SMT)	Independent	This is computed as the amount of securities traded divided by the market capitalization.	(-) (+)	Lestari et al., (2020)
Stock Market Total Value Traded (STVT)	Independent	This is computed as the total value of shares traded, foreign and domestic multiplied by their respective equivalent prices divided by the GDP.	(-) (+)	Lestari et al., (2020)
Gross Domestic Product Per Capita (GDPPC)	Independent	Measured as gross domestic product (GDP) divided by population	(+) (-)	Hasan et al., (2021)
Energy Consumption (ENC)	Control	It expresses the amount of energy utilised annually by every individual in a nation and is measured as the total primary energy consumption per capita. Put another way, it's the	(+)	Longe et al., (2020)

		population to energy consumption ratio.		
Urbanization (URB)	Control	Calculated as the number of persons living in urban regions divided by the entire population, or the urban population as a proportion of the overall population.	(+)	Kwakwa & Alhassan (2020)
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	(+)	Isiksa et al., (2019)
Secondary School Enrolment Rate (SER)	Control	Calculated as the Percentage of Secondary School Enrolment	(+)	Kwakwa & Alhassan (2020)

Source: *Author's compilation* (2024)

3.9 Data Estimation Techniques

For the panel analysis in this study, the Mean Group (MG) and the Pooled Mean Group (PMG) will be used to evaluate the long- and short-term relationships among the variables. Using the Autoregressive Distributed Lags (ARDL) approach, this study will further assess the long-run and short-run connection among the variables for specific nations. Understanding the dynamic impact of financial development and economic expansion on environmental deterioration throughout the sample countries requires this. To accurately characterise the nature of our data, we will also do 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 will apply 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 will 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. Eview 9.0 software will be used to conduct all data analysis.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS OF RESULTS

4.1 Introduction

In this chapter, the focus is on the presentation and analysis of the data as well as estimation and interpretation of the models used for the empirical evaluation of the study. The estimation results are presented in line with the working objectives of the study. The analysis involves the use of both statistical and econometric methods in order to provide a rich background for the investigation. The basic characteristics of the dataset are outlined by the descriptive statistics, including charts and correlation analysis. These statistics are used to provide the initial pattern of movements and co-movements of the datasets so as to form the background for the analysis on the basis of inferential statistics. The Econometric analysis is performed based on objectives of the study. In particular, a dynamic framework was devised for the empirical analysis and the pooled mean group (PMG), which is a panel version of the ARDL estimation technique, was used for the empirical analysis. Series of estimations and testing procedures are conducted in line with the objectives of the study. In particular, the instruments for testing the hypothesis of the relationship between greenhouse gas (GHG) emission and the explanatory variables differs from the instrument for testing the Kuznets curve hypothesis. The datasets are initially tested to observe their time series and cross-sectional characteristics.

4.2 Data Presentation

The data from 1990 to 2022 are presented in appendix 1.

4.3 Data Analysis

4.3.1 Descriptive Statistics

The pattern of data characteristics is initially highlighted by presenting trends in relevant variables and then the related summary statistics.

4.3.1.1 Trend Analysis

Figure 4.1 shows the trend in total CO2 emission for the countries included in the study. It is seen that emissions from all the countries increased over the period, suggesting that SSA countries are increasing their environmental degradation component in the globe. Although the amount is low, compared to other advanced economies, the trend shows that the contribution of SSA countries is on the rise. Each of the countries has had strong increases in the CO2 emission since 1990. IN CIV, the emission moved from 4,000,000 tonnes in 1990 to over 10,000,000 tonnes in 2022, while it moved from 40,000,000 tonnes in 1990 to 120,000,000 tonnes in 2022 for Nigeria. These are large and strong movements in the contribution to environmental degradation over the period.

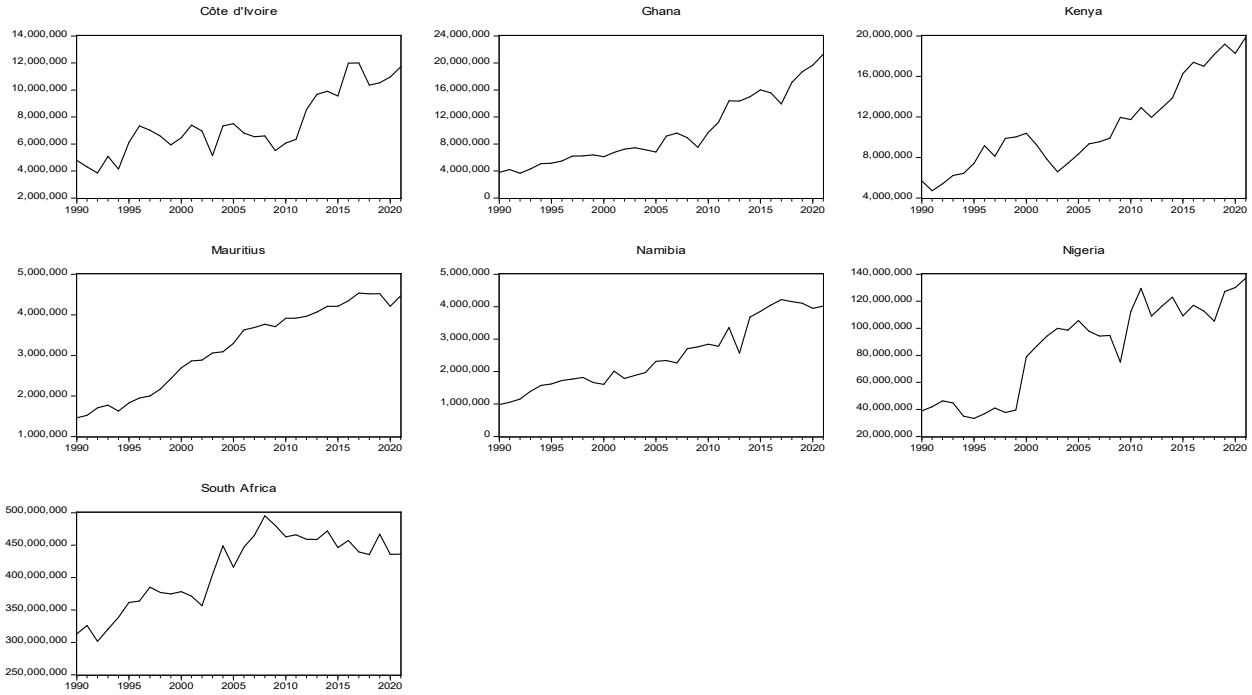


Figure 4.1: Trends in CO2 emission

Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

The other environmental degradation variable in the study is the ecological footprint, which is considered in terms of per capita footprint on cropland (EFPC) and on built-up land (EFPI). The trends in both per capita footprints for the countries is presented in Figure 4.2. In Ghana and Kenya, the trends are similar for both footprint cases. The quantity of the two per capita ecological footprint is however different among the countries. While the crop-related footprint is larger in CIV, Namibia and partly in South Africa, the built-area footprint is more pronounced in Ghana, Nigeria and Mauritius. Also, apart from Mauritius where the footprint appears to be declining, the trend is either relatively flat or upward for the SSA countries. This suggests that ecological footprint in SSA is slightly on the increase, over the years. Countries like Nigeria, CIV and South Africa also experiences divergent trends in the direction of movement of the two

ecological footprint variables in the last few years. This provides an additional dimension to the ecological footprint issues for these countries.

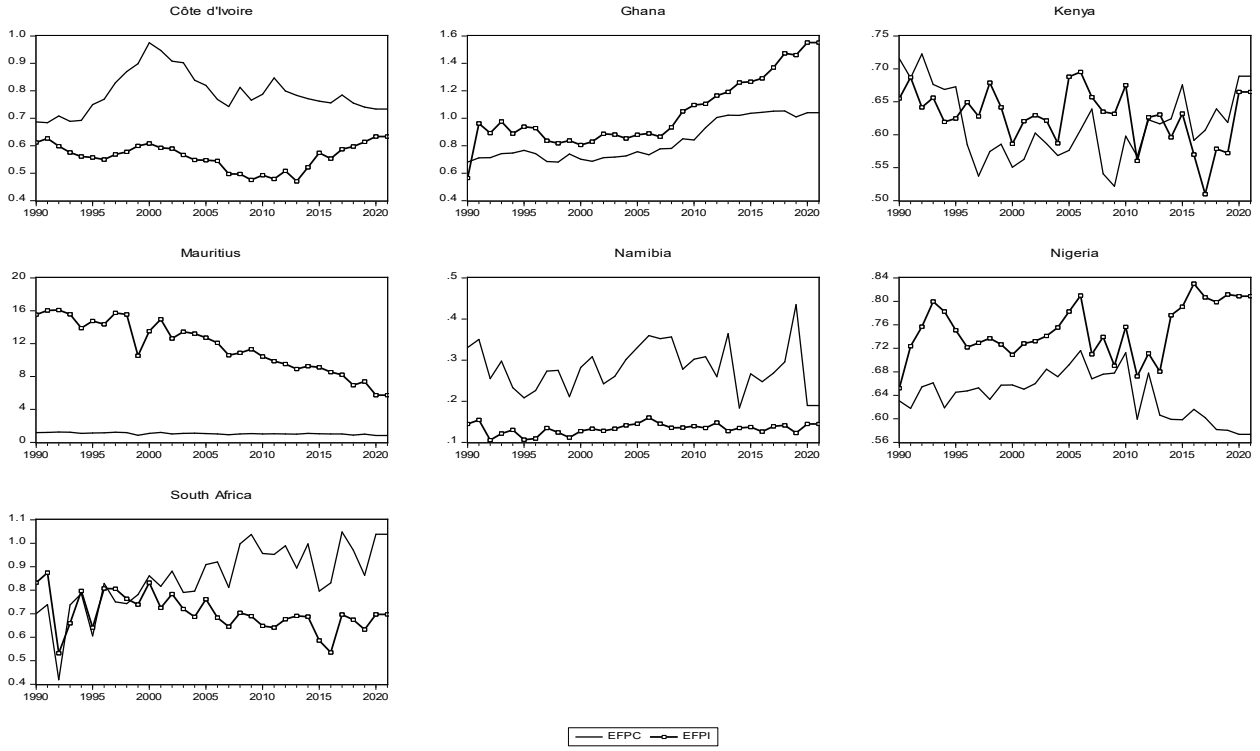


Fig. 4.2: Trends in Ecological Footprint

Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

The trends in the financial development variables for the economies are also reported. In Figure 4.3, the trends in the money market factors are presented. As expected, the financial liquidity (LLR measured as M2/GDP ratio) is higher in each of the countries than the credit to GDP ratios. There is a positive trend in the two variables for each of the countries, indicating that there is general expansion of the financial sector. This also suggests positive trends in financial development (especially in the money markets) for SSA countries since the 1990s. The trend has

however not been smooth for the countries over the years. For instance, there was a significant decline in both ratios for CIV between 1995 and late 2010s, indicating that the economy faced significant financial system drain over the period. Nigeria experienced a sharp boost in the credit ratio between 2005 and 2008, which was followed by a sharp decline in 2009. Also, South Africa has experienced significant decline in credit ratio since 2017. Thus, there are different time-paths in the movement of financial development among the countries, although there is a general upward trend since 1990. The movement of overall financial liquidity in the economies also appears to be smoother than the trend in credit ratio.

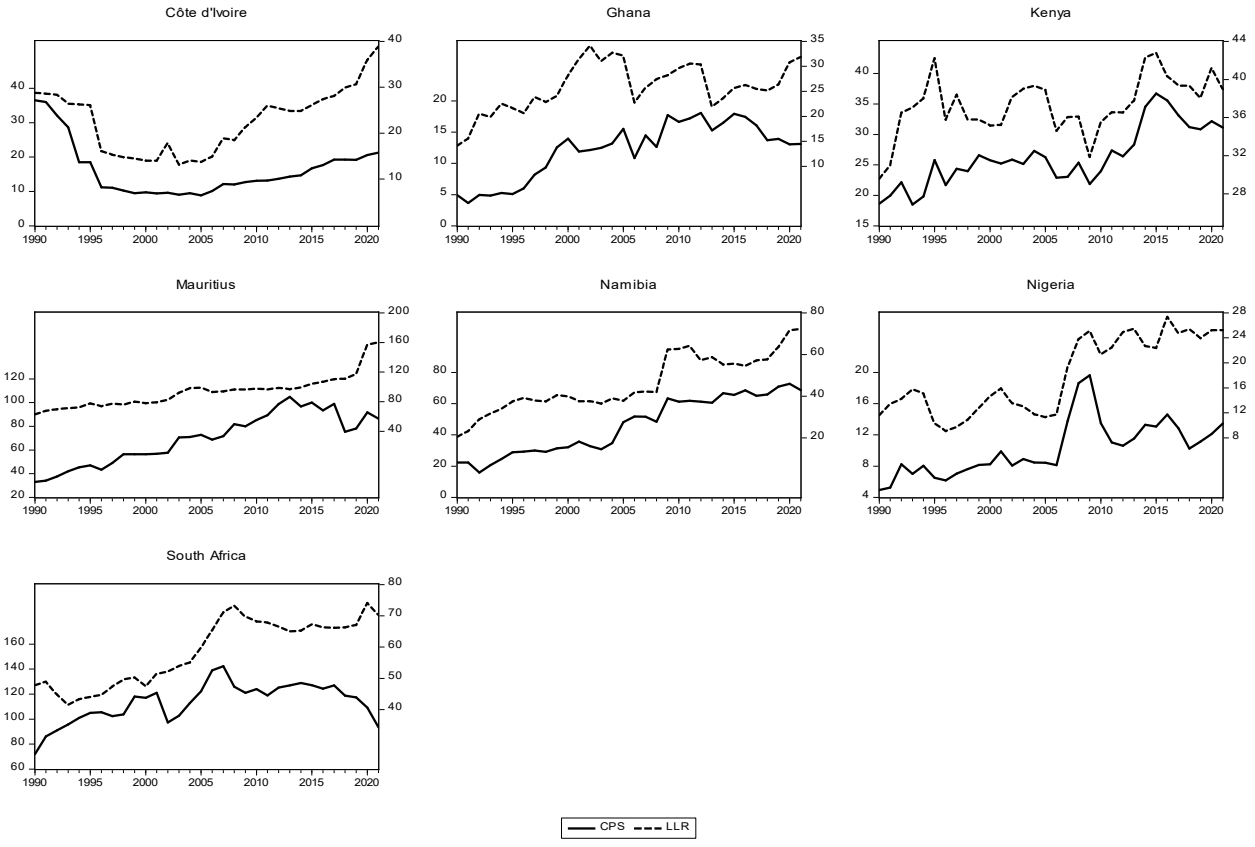


Fig. 4.3: Trends in Credit and Financial Liquidity

Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

The trend in the capital market component of financial development is presented in Figure 4.4 which shows movements in stock market capitalization to GDP ratio and stock market turnover for the countries. It is seen that market capitalization has not been smooth in terms of their annual values. Also, only South Africa experienced and upward trend for the two variables over the period. The long-term trend in other countries has remained flat, with Ghana experiencing a downward trend in market capitalization since 2015. There is therefore evidence that the capital market component of financial development has not expanded in the SSA region over the years. There are only marginal changes in the capital market development indicators which are often decimated within short periods.

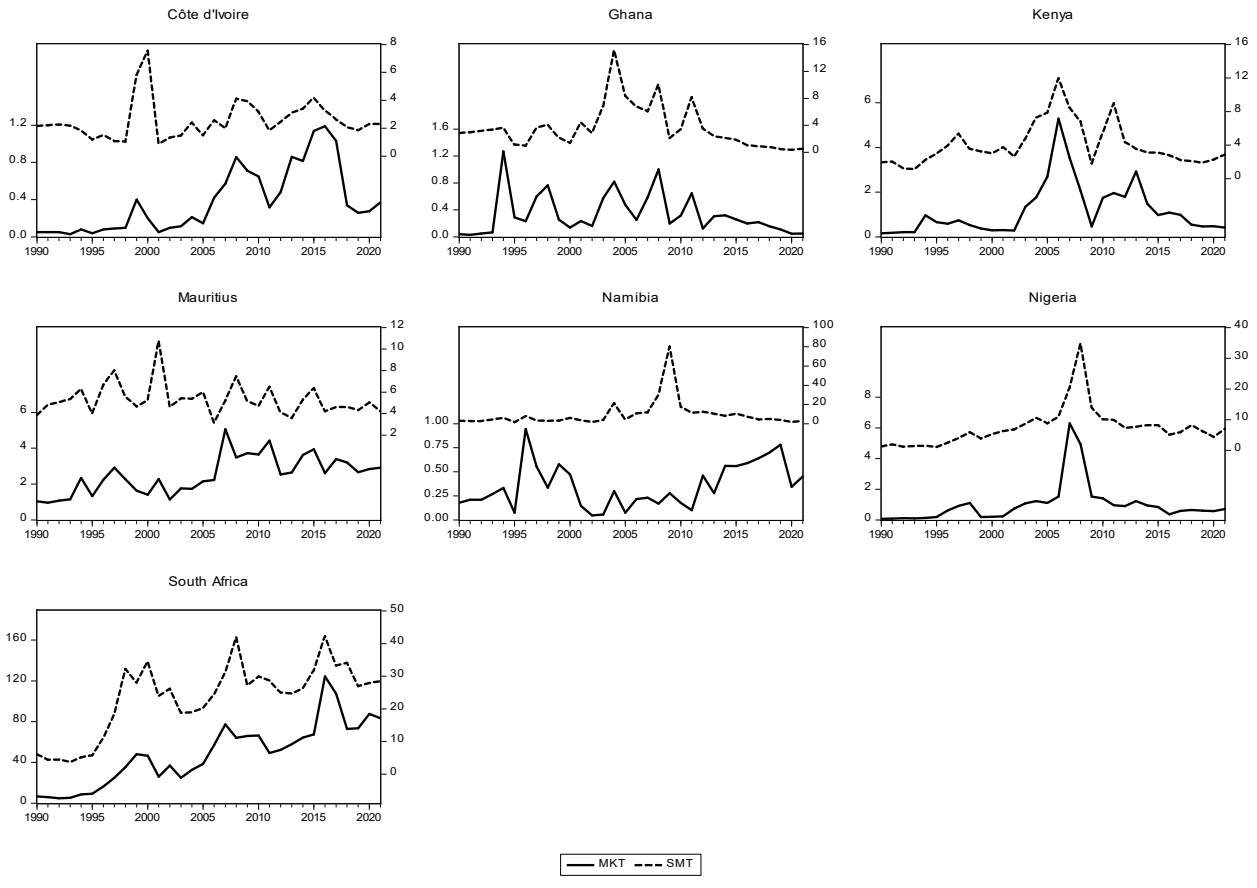


Fig. 4.4: trends in Capital Market Development Variables

Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

The descriptive statistics for the panel of seven countries used in the empirical analysis is presented in Table 4.1. Average annual growth in CO_2 emission by the countries was 4.51 percent, with a standard deviation of 13.39. This average growth rate is generally high, given that annual global growth rate of CO_2 emission was reported at 0.98 percent in 2022 by the International Energy Agency. Thus, there is evidence that although the total quantity of CO_2 emission is low in the SSA region, the region is one of the fastest growing emitters in the globe. The standard deviation of 13.36 show that there are wide variations in the annual emission among countries and within the time period of the study. Average ecological footprint of 2.20 tonnes per capita on the built environment is higher than the footprint on crop land of 0.73 tonnes per capita. This shows that the effect of degradation is more pronounced from human activities in the cities and towns.

Table 4.1: Descriptive Statistics for Panel Data

Variable	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	J-B	Prob.
GCO2	4.51	99.11	-26.23	13.39	2.12	14.71	1402.96	0.00
EFPC	0.73	1.24	0.18	0.25	-0.28	2.68	3.83	0.15
EFPI	2.20	16.08	0.11	4.00	2.35	7.05	348.42	0.00
CPS	42.46	142.42	3.66	37.82	1.03	2.74	38.99	0.00
LLR	43.54	160.06	9.06	27.08	1.37	5.17	111.04	0.00
MKT	7.92	124.37	0.03	20.48	3.20	13.14	1300.03	0.00
SMT	8.16	80.38	0.35	10.03	2.99	15.96	1842.94	0.00
FDI	2.23	10.66	-1.42	2.25	1.58	5.19	133.22	0.00
GGDPPC	1.59	12.28	-14.60	3.38	-0.75	5.81	91.92	0.00
URB	42.46	67.85	17.04	11.83	-0.19	2.64	2.47	0.29
SER	2.05	4.01	1.24	0.42	0.65	5.84	88.52	0.00
GENC	2.83	187.03	-31.43	18.01	6.48	62.24	33248.26	0.00

Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

For the financial development variables, average credit to GDP ratio for the countries is 42.46 percent over the period, although the maximum value is as large as 142.42 percent and the minimum value is 3.66 percent. This shows that across the SSA region, there is a level of credit

market depth. Average financial liquidity in the economy is similar to the credit ratio at 43.54 percent, suggesting that financial depth is similar in terms of credit and money supply in the region. The capital market indicators are however quite varied across the countries. Average market capitalization to GDP ratio is 7.92 with a standard deviation of 20.48. This shows are high level of variation in the capital market depth among SSA countries. Stock market returns (which show liquidity in the capital market) is also relatively low on average at 8.16 percent, with a high standard deviation that suggests that some countries have market returns values that are largely different from the mean value. The skewness for both capital market development variables is high at 3.2 and 2.99 for MKT and SMT respectively. This shows that much of the reported capital market indicators for the countries are less than the reported mean values. Average FDI to GDP ratio for the countries 2.23, with a maximum of 10.66, which is generally low for a region that seeks to expand capital base. Average urbanization is high at 42.46 percent for the region, with a low standard deviation of 11.83 indicating that the high urban rate is similar across the SSA countries. Average secondary school enrolment is 2.05 percent while average growth in electricity consumption is 2.83 percent.

The descriptive statistics for the individual countries are also reported in this in Table 4.2. It shows the summary of the variables for the countries. It is shown that Ghana experienced the highest growth rate of CO2 emission among the countries with an average growth rate of 6.39 percent. Namibia and Nigeria also have high annual growth rates in terms of CO2 emission. Mauritius however has the highest ecological footprint per capital among the countries, which suggests that the country has a high rate of decline in ecological structure relative to the population of the country. Namibia has the lowest ecological footprint among the countries. In terms of the financial development variables, South Africa has the highest credit to GD ratio at

113.5 percent and Nigeria has the lowest credit to GDP ratio at 10.27 percent. Nigeria also reported the lowest average financial liquidity ratio at 17.95 percent. This indicates that Nigeria is among the least financially developed economies in sub-Saharan Africa. South Africa has very high values of market capitalisation ratio on average over the period of the analysis. The value is far greater than the annual averages of other SSA countries. This shows that South Africa is far ahead of other SSA countries in terms of development and depth of the capital market.

Table 4.2: Descriptive Statistics for Individual Countries

COUNTRY	GCO2	EFPC	EFPI	CPS	LLR	MKT	SMT
Côte d'Ivoire	4.32	0.79	0.56	16.20	22.70	0.38	2.55
Ghana	6.39	0.84	1.04	12.15	25.85	0.34	3.68
Kenya	4.72	0.62	0.63	26.30	37.30	1.17	4.02
Mauritius	3.79	1.06	11.66	69.75	93.52	2.51	5.33
Namibia	5.30	0.28	0.13	46.02	46.18	0.35	9.66
Nigeria	5.85	0.64	0.75	10.27	17.95	1.01	7.48
South Africa	1.21	0.85	0.70	113.25	58.49	48.21	23.30

Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

Another aspect of the descriptive statistics in this section is to review the initial pattern of relationship among the variables of the study. The focus is particularly on the independent variables in order to determine whether the correlation indexes can constitute multicollinearity problems in the estimated models. The correlation matrix is resented in Table 4.3. Among the environmental degradation variables, there is a high positive correlation between the two ecological footprint variables, indicating that for any country, increased ecological footprint on cropland is correlated with higher footprint in the built environment. The correlation between CO2 emission and the two ecological footprint variables however is however low and actually

negative with built area ecological footprint. This shows that CO2 emission does not necessarily imply rising ecological footprint in a country.

Among the financial development variables, there is a between credit ratio and each of the other financial development variables. This shows that credit supply in an economy is a basic financial development component that may spur other financial development indicators (irrespective of whether it is money or capital market) at any given time. The correlation between financial liquidity in the economy and the capital market variables is weak, although positive. This suggests that capital market depth is more related to credit penetration or development than to overall financial liquidity in the economy. There are also strong positive correlations between urban rate and financial development and between school enrolment rate and financial development. All the financial development indicators also have strong positive correlation with both GDP per capita and electricity consumption rate for the countries. This suggests that financial development moves together the level of a country's social and physical development. Among the explanatory variables, none of the correlation coefficients is greater than 0.75 which is the benchmark for observing multicollinearity. Thus, we do not expect multicollinearity in the models estimated for the study.

Table 4.3: Correlation Matrix

Variable	CO2	EFPC	EFPI	CPS	LLR	MKT	SMT	GDPPC	FDI	ENC	URB	SER
CO2	1											
EFPC	0.21 (0.00)	1										
EFPI	-0.19 (0.00)	0.61 (0.00)	1									
CPS	0.72 (0.00)	0.24 (0.00)	0.23 (0.00)	1								
LLR	0.17 0.01	0.34 0.00	0.64 0.00	0.64 0.00	1							
MKT	0.86 (0.00)	0.27 (0.00)	-0.10 (0.14)	0.61 (0.00)	0.29 (0.00)	1						
SMT	0.68 (0.00)	0.05 0.42	-0.11 0.11	0.60 0.00	0.25 0.00	0.72 (0.00)	1					
GDPPC	0.35 0.00	0.32 0.00	0.54 0.00	0.68 0.00	0.71 0.00	0.40 0.00	0.35 (0.00)	1				
FDI	-0.16 (0.02)	-0.11 0.12	-0.07 (0.30)	-0.01 0.85	0.04 0.53	-0.08 0.26	0.12 0.06	0.09 (0.19)	1			
ENC	0.82 0.00	0.19 0.00	0.09 (0.20)	0.68 (0.00)	0.58 0.00	0.62 0.00	0.62 0.00	0.62 0.00	0.00 (0.94)	1		
URB	0.63 0.00	0.41 0.00	0.02 (0.73)	0.51 0.00	0.21 0.00	0.57 0.00	0.45 0.00	0.39 0.00	0.13 0.06	0.61 (0.00)	1	
SER	0.35 (0.00)	0.27 (0.00)	0.27 (0.00)	0.62 (0.00)	0.67 (0.00)	0.51 (0.00)	0.37 (0.00)	0.60 (0.00)	0.24 (0.00)	0.54 (0.00)	0.37 (0.00)	1

Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

A further analysis of the relationships among the variables is conducted using scatterplots with focus on the financial development indicators. The goal is to observe how movements in one financial development variable influences the others. The plot in Figure 4.5 shows the relationship between credit ratio and financial liquidity in the economy. There is a positive between the two money market-related variables. The regression line is strong with a high coefficient of determination. It shows that with every one percent rise in credit supply to GDP ratio, financial liquidity rises by 0.57 percent. This is more than halve share of the relationships. The relationship between market turnover and market capitalization is also presented in Figure 4.6 and indicates a positive relationship, although the slope is flatter with a slope of 0.374.

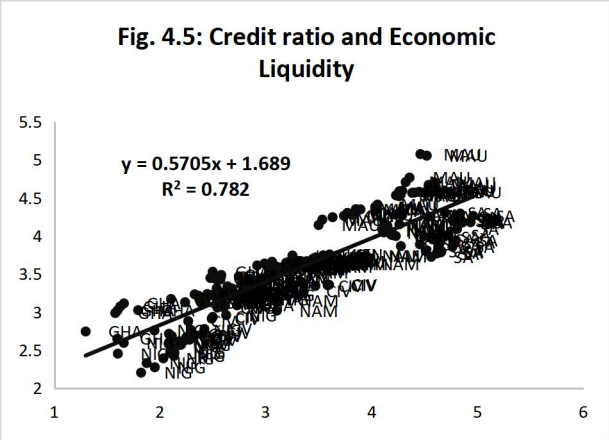


Fig. 4.5: Credit ratio and Economic Liquidity

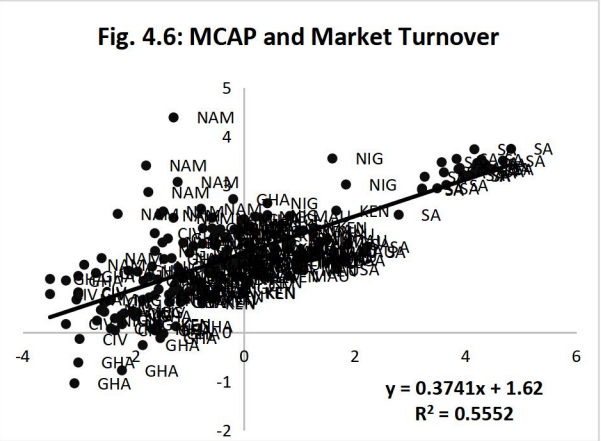
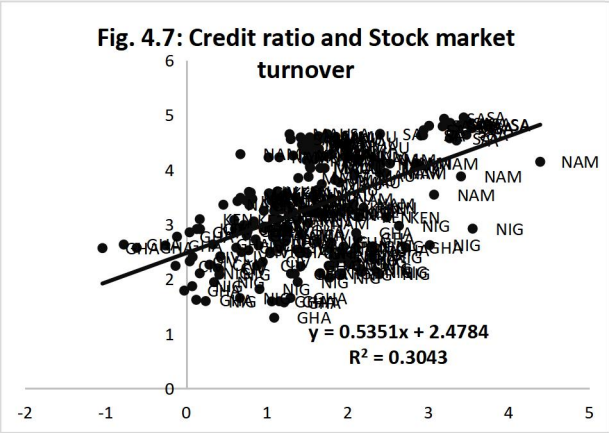
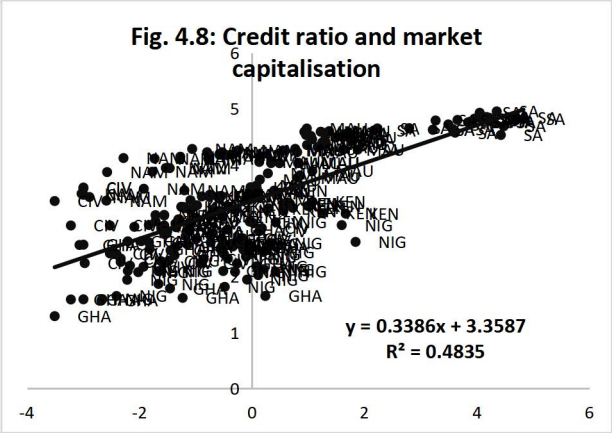


Fig. 4.6: MCAP and Market Turnover

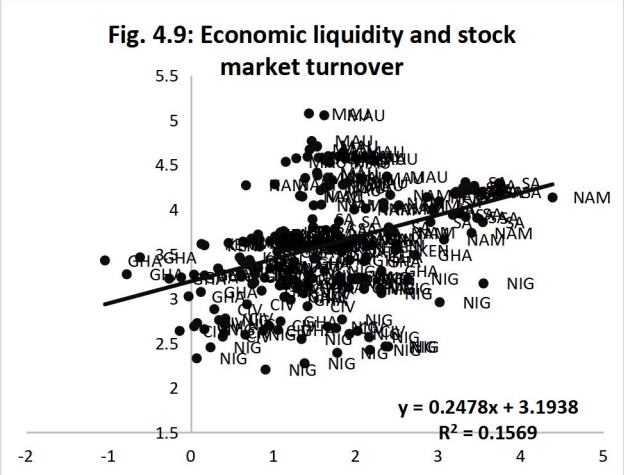
Source: Author's computation (2024) with the aid of E-view 9.0 econometric software

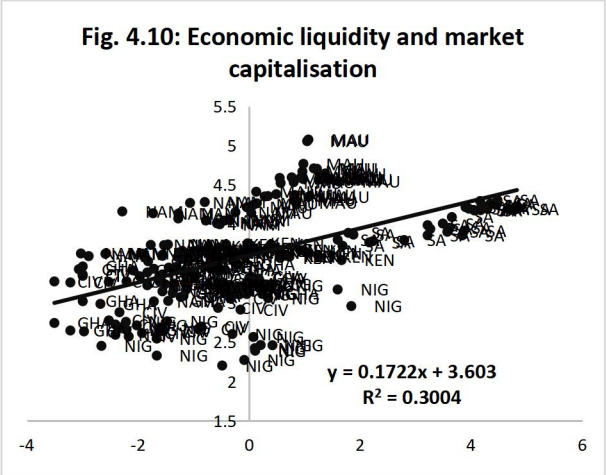
The relationship between credit ratio and stock market turnover is plotted in Figure 4. and indicates a positive relationship. The slope of the regression line indicates a 0.53 percent shift in stock market return with every percentage rise in credit ratio, although the R-squared value is low. The correlation between credit ratio and market capitalization (shown in Figure 4.8) is lower than that of stock market turnover.





Figures 4.9 and 4.10 also show the relatiosnhip between financila liquidity and the two capital market development variables. It also shows that with increased monetary deepening in an economy, the capital market also experiences debvelopment both in terms of cap[italisation and the liquidity of the market.





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

4.3.1 Test for Normality

In this section, the characteristics of the panel data used for the empirical analysis are tested and evaluated in order to ensure that the estimates in the study are sable. The initial test conducted is the normality test which seeks to evaluate level of heterogeneity or stability of the dataset. Note

that heterogeneity is a property of panel data and fits the dataset into a panel data analysis framework. Figure 4.5 shows the test of normality using the distribution patterns of the datasets in the plotted quantiles. If the probability density of a given dataset is normally distributed, the points in the QQ-plots should lie alongside a straight line. As shown in Figure 4.5, for all the datasets, the distributions do not lie entirely on the straight diagonal. Although the plot for URB appears to be close to the diagonal, the edges tail away from the line, which also shows non-normal distribution. There is therefore evidence from the normality tests that there are extreme portions in the datasets, possibly due to deviations across the cross sections of the dataset.

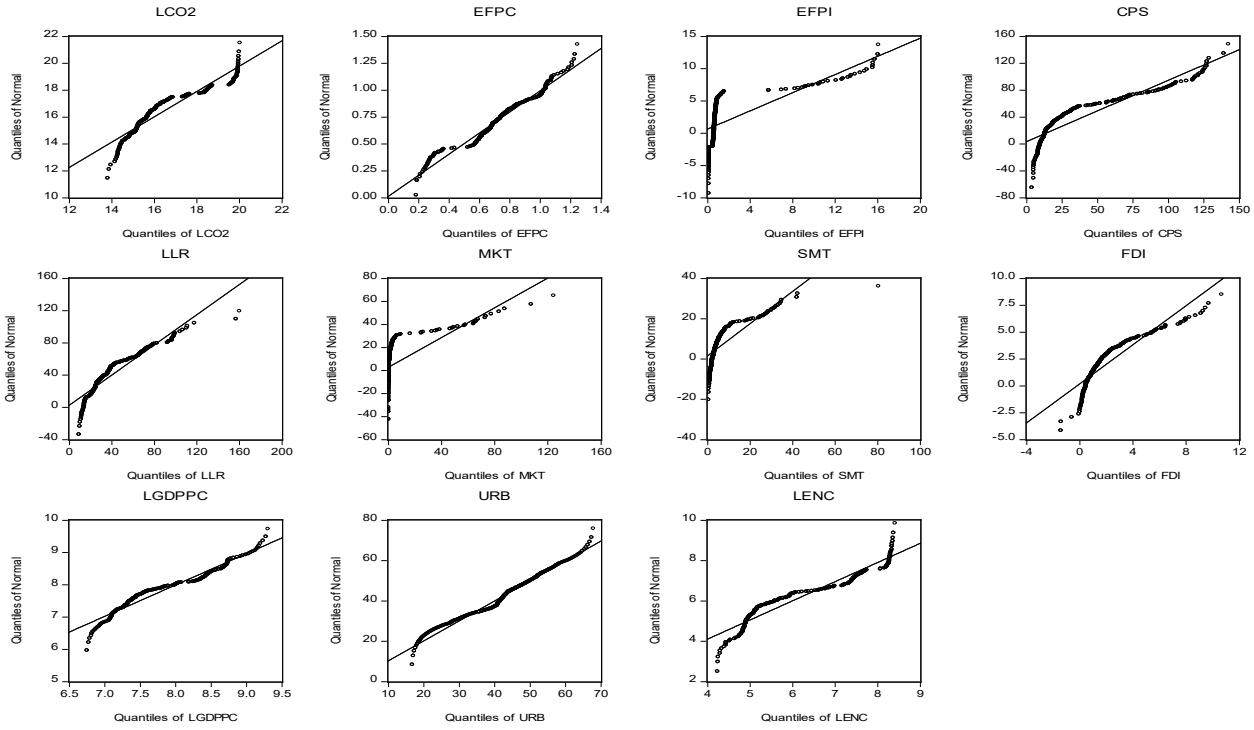


Fig. 4.1: The Quantile-Quantile Plots for Variables

4.3.2 Panel Unit Root Test

The countries included in the empirical analysis are highly heterogenous in terms of the environmental degradation and financial development (as seen in the descriptive statistics).

Hence, the country-level panel data used in the empirical analysis are likely to exhibit both country-specific characteristics (individual heterogeneity) and common (homogenous) characteristics. This implies that there is need for the use of panel unit root tests to check for the stationarity of the data – especially those that combine the two panel influences. In this study, the test developed by Levin, Lin and Chu (LLC) was used to examine the stationarity properties of the homogenous panel. This test assumes identical cointegration vectors among the countries. Given that each of the country in the study is likely to exhibit differences in their emissions, especially as it relates to institutional and outcomes, heterogenous-based results from the Im, Pesaran and Shin (IPS, 2003) and the Augmented Dickey-Fuller tests are also included in the study. The unit root test is conducted for the variables in levels and in first differences. The results of the unit root test in levels are presented in table 4.4 below.

Table 4.4: Panel Data Unit Root Tests Results in Levels

Variables	*Common unit process*	*individual unit root process*		
	LLC	**IPS**	**ADF**	**PP-Fisher**
LCO2	-2.63**	0.37	10.31	9.72
EFPC	0.21	-0.52	17.31	33.82*
EFPI	2.06**	-0.60	28.41*	43.53*
LLR	0.96	1.21	14.37	14.69
CPS	-2.58**	-1.38	21.19	17.33
MKT	-3.26**	-2.87*	31.65*	38.62*
SMT	-4.27**	-4.35**	46.97**	53.42**
ENC	-0.93	1.39	8.11	6.53
GDPPC	0.17	2.92	4.03	3.66
FDI	-2.25**	-3.56**	36.96**	52.69**
URB	0.07	3.60	4.61	27.41
SER	-1.80	5.72	4.87	0.64

Source: Estimated by the Author. *Note: ** and * indicate significant at 1% and 5 % levels respectively; IPS = Im, Pesaran & Shin; LLC = Levin, Lin & Chu*

The unit root test is based on the significance of the coefficients of the test statistics at the 5 percent level. It is seen that some of the variables pass the significance test at the 5 percent level, which shows that they are stationary in levels, while other variables fail the significance test.

Thus, some of the variables are shown to be I(0). The unit root test of stationarity for the variables in their first differences is reported in Table 4.5. In the result, it is seen that all the variables are stationary. The variables that were not stationary in levels have become stationary after first differences. This implies that some of the variables are integrated of order zero (I[0]), while others are integrated of order one (I[1]).

Table 4.5: Panel Data Unit Root Tests Results in First Differences

Variables	*Common unit process*	*individual unit root process*		
	LLC	**IPS**	**ADF**	**PP-Fisher**
LCO2	-7.60**	-8.61**	93.85**	176.2**
EFPC	-10.51**	-12.77**	132.8**	186.4**
EFPI	-7.13**	-13.28**	138.8**	209.4**
LLR	-5.98**	-6.84**	74.92**	156.2**
CPS	-5.04**	-5.84**	61.65**	125.7**
MKT	-10.51**	-11.09**	123.6**	188.3**
SMT	-12.06**	-11.49**	128.5**	189.4**
ENC	-6.67**	-6.79*	72.29**	165.7**
GDPPC	-4.00*	-3.28*	34.14**	69.85**
FDI	-7.49**	-10.75**	120.0**	189.4**
SER	4.03*	1.63	7.618	45.62**
URB	3.86*	3.56*	5.673	6.83

Source: Estimated by the Author. *Note: ** and * indicate significant at 1% and 5 % levels respectively; IPS = Im, Pesaran & Shin; LLC = Levin, Lin & Chu*

4.3.3 Cross-sectional Dependence Test

The cross-sectional dependence tests are also conducted for each of the three equations estimated in the study. This test helps to evaluate the cross-sectional properties of the panel dataset by examining the issue of cross-section correlations in the data. Note that the data used in the study are all from the sub-Saharan African region which possess similar long run economic patterns. This pattern of influences is expected to generate certain levels of interdependencies among each of the countries in the study and may lead to spatial autoregressive processes within the datasets. The problem and presence of cross-sectional dependence in the study is investigated by

implementing the Pesaran (2004). The data used in this study has a panel structure where the cross-sectional dimension (7 countries) is less than the time dimension (33 years) - (i.e., N < T). Given this pattern of panel setup, the Pesaran cross sectional dependence (CD) test is more appropriate. The null hypothesis for the Pesaran CD test is the absence of cross-sectional dependence. Hence, it is expected that the test statistics fail the significance tests at the chosen level of significance (5% in this case) in order to ascertain the absence of cross-sectional dependence in the data. The Pesaran cross-section dependence test results are presented in Table 4.6.

Table 4.6: Cross-section Dependence Test Results

Equation series tested	Pesaran CD	P-value	Abs corr
CO2	0.635	0.516	0.144
EFC	1.123	0.239	0.195
EFPI	-0.692	0.488	0.170

Source: Author's computations (2024)

From the results reported in Table 4.6, it is seen that the Peseran CD test statistics for each of the equations fail the significance tests at the 5 percent level (p value > 0.05). This shows that for these equations, there is absence of cross-sectional dependence in the estimates. The absence of cross-sectional dependence indicates that the estimated equations are free of heteroskedastic influences.

4.3.4 Bounds Test for Cointegration

The unit root test above shows that the variables in the analysis have mixed orders of integration, with some integrated at order zero and others integrated at order one. An appropriate cointegration test is therefore required to be able to evaluate the long run properties of the dataset.

Hence, the Bounds test for cointegration, which is suited for autoregressive distributed lags (ARDL) based analysis is used for testing the cointegration status for the three combination of variables that make up the model specified. Moreover, the application of error correction processes (based on the ARDL approach to cointegration) further indicates the relevance of the cointegration tests. Based on the Bounds testing procedure for cointegration, strong cointegration is only demonstrated to exist if and only if the equation with the dependent variable (*Y*) passes the cointegration test. The following procedure is used for evaluation: if at the 5 percent significance level, the estimated F-value is greater than both the lower test (I0 Bounds) and the upper test (I1 Bounds) values, then there is no cointegration among the variables. If the estimated F-value lies between the two Bounds values, then there is need to proceed with a lesser structure of the ECM analysis by applying the Josselius procedure. The results of the Bounds test for cointegration for the equations for each of the countries are shown in Table 4.7 and the evaluations are based on the critical F-statistic values for the lower and upper bounds.

Table 4.7: Results of Bounds Test of Cointegration

Country	F-statistic	I(0)	I(1)
Côte d'Ivoire	54.86	2.04	2.08
Ghana	3.72	2.04	2.08
Kenya	82.93	2.04	2.08
Mauritius	11.34	2.04	2.08
Namibia	13.44	2.04	2.08
Nigeria	5.12	2.04	2.08
South Africa	2.12	2.04	2.08

Source: Author's computation (2024)

From the Table, the F values for the tests are all greater than both the lower and upper Bounds values at the 5 percent levels. According to the empirical output of the F-values in all the panels of Table 4.7 therefore, it can be seen that the null hypothesis of no cointegration between the environmental degradation variables and financial development the selected countries can be rejected at the 5 percent level of significance. These results reveal that for the countries, there is cointegration among the variables and they move together over time or in the long run.

4.4 Regression Analysis

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 seven SSA countries, which implies that both the short-run and the long run relationships are determined. Note that the optimal lag length for estimating the PMG analysis was selected suing both the Akaike Information criterion (AIC) and the Schwarz Information criterion (SIC). Both of the criteria indicated that the lag length of two is optimal for estimating the panel data relationship.

4.4.1 Regression Results for the Effects of Financial Development on Environmental Degradation

The result for the short run estimates of the relationships is presented in Table 4.8. Given that the PMG results are reported, the goodness of fit statistics (including R-squared and F-statistics) are not estimated. Rather, we consider the standard error of estimates to evaluate the goodness of fit for the relationships. In the results for CO2, EFPC and EFPI, the standard error of estimates are sufficiently low. Moreover, the ratios of the standard errors to the mean of dependent variable in

each of the cases is less than 0.05 in absolute values. Thus, it can be shown that the estimates (both short-run and long-run) have overall good fit.

Table 4.8: Short Run PMG Estimates

Variable	*LCO2*			*EFPC*			*EFPI*		
	Coeff.	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**
Constant	3.172	2.934	0.00	0.030	0.140	0.89	0.510	0.423	0.67
ΔCPS	0.006	0.886	0.38	-0.003	-1.641	0.11	-0.006	-1.629	0.11
ΔCPS_{t-1}	-0.003	-0.677	0.50	-0.003	-1.519	0.13	-0.004	-0.445	0.66
ΔLLR	-0.012	-2.118	0.04	0.002	0.654	0.52	0.019	1.019	0.31
ΔLLR_{t-1}	-0.001	-0.349	0.73	-0.003	-0.579	0.56	-0.014	-2.031	0.05
ΔMKT	0.066	1.656	0.10	-0.015	-1.334	0.19	-0.065	-1.454	0.15
ΔMKT_{t-1}	0.097	1.349	0.18	-0.005	-1.058	0.29	-0.117	-1.160	0.25
ΔSMT	-0.009	-1.239	0.22	0.004	1.048	0.30	0.043	0.878	0.38
ΔSMT_{t-1}	-0.016	-2.085	0.04	0.006	1.454	0.15	0.079	1.017	0.31
ΔLGDPPC	0.135	0.247	0.81	1.490	2.342	0.02	8.579	1.285	0.20
$\Delta LGDPPC_{t-1}$	0.237	0.663	0.51	0.698	1.537	0.13	-5.896	-0.902	0.37
ΔLENC	0.330	1.236	0.22	-0.270	-1.156	0.25	-0.624	-1.213	0.23
$\Delta LENC_{t-1}$	0.277	1.491	0.14	-0.279	-1.068	0.29	0.152	0.164	0.87
ΔURB	3.655	1.501	0.14	0.678	1.241	0.22	-6.678	-1.009	0.32
ΔURB_{t-1}	-3.518	-1.450	0.15	-1.508	-2.048	0.04	-0.769	-0.729	0.47
ΔFDI	0.007	0.549	0.58	-0.011	-1.479	0.14	-0.039	-1.376	0.17
ΔFDI_{t-1}	0.000	0.020	0.98	-0.004	-0.925	0.36	0.027	0.774	0.44
ΔSER	3.688	1.238	0.22	3.774	0.998	0.32	27.358	1.100	0.27
ΔSER_{t-1}	4.828	0.990	0.33	-1.148	-0.299	0.77	-48.494	-1.109	0.27
ECM_{t-1}	-0.511	-2.882	0.01	-0.659	-4.042	0.00	-0.010	-0.153	0.88
S.E. of reg.	0.088			0.000			-0.047		
Mean dep. Var.	0.038			0.049			0.401		

Source: Author's computation (2024)

A close evaluation of the individual coefficients of the explanatory variables in the CO2 Equation reveals that among the financial development variables, only the coefficients of current LLR and the first lag of SMT passed the significance test at the 5 percent level. Both of the coefficients are negative and show that financial liquidity has a negative immediate short run impact on CO2 emission, while stock market returns has also has a negative but delayed short

run impact. These coefficients are small among the different lags of the financial variables reported in the result. This shows that in general, financial development has a relatively weak short run effect on CO2 emission by countries in SSA. This weak effect is however negative, which shows that financial development slightly alleviates environmental degradation among the countries in the short run.

For the ecological footprint estimates the results for the cropland effects (shown in the middle panel of the results in Table 4.8) indicates that none of the coefficients of the financial development variables passed the significance test at the 5 percent level. For the ecological footprint on the built area (EFPI) model, only the coefficient of lagged financial liquidity ratio is significant at the 5 percent level. These general results clearly show that financial development does not have significant short run effect on ecological footprint among SSA countries. The effects may be more long term as suggested by the coefficients of the error correction terms (ECM) in each of the estimates. The coefficients all possess the expected negative sign and those of CO2 and EFPC are significant at the 1 percent level. This shows that long run equilibrium in the environment will be restored after any short run shock or disequilibrium in the system. This outcome shows that there is a link between the short run and the long run outcomes of environmental degradation among the countries when financial development and other factors in the model are taken into cognizance.

The long run estimates of the relationships are presented in Table 4.9a. The long run estimates are designed to demonstrate the stable effects of the financial development variables and other variables on environmental degradation over time. In essence, the estimates show how the environment stabilizes after all the adjustments have been made in the long run following short run changes in the explanatory variables. The coefficient of CPS fails the significance test in the

CO2 estimate, indicating that credit ratio does not significant influence the long run behaviour of environmental degradation among the countries. The coefficient of CPS is however significant in both the ecological footprint equations at the 5 percent level. The coefficient is positive in the EFPC result, but negative in the EFPI result. This shows that increased credit ratio in the economy increases the ecological footprint in relation to cropland but reduces the footprint in relation to built-up areas. This divergent result suggests that credit deepening in the economy may not be an effective tool for influencing the direction or dimension of environmental degradation among SSA countries.

Table 4.9a: Long Run PMG Estimates

Variable	*LCO2*			*EFPC*			*EFPI*		
	Coeff.	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**
CPS	0.002	0.572	0.57	0.003	3.016	0.00	-0.051	-2.453	0.02
LLR	-0.017	-4.133	0.00	0.001	1.059	0.29	-0.063	-2.330	0.02
MKT	-0.102	-4.234	0.00	-0.006	-8.035	0.00	0.091	2.387	0.02
SMT	0.020	3.801	0.00	-0.009	-6.738	0.00	-0.187	-2.730	0.01
LGDPPC	0.819	4.330	0.00	0.045	0.563	0.58	8.023	2.444	0.02
LENC	0.178	3.025	0.00	0.080	2.244	0.03	-4.659	-2.661	0.01
URB	0.076	4.063	0.00	0.028	8.209	0.00	0.142	1.595	0.11
FDI	0.004	0.389	0.70	0.003	2.220	0.03	-0.235	-2.759	0.01
SER	-0.417	-0.716	0.48	-0.687	-8.770	0.00	-10.572	-2.372	0.02

Source: Author's computation (2024)

The coefficient of financial liquidity ratio for the economies (LLR) is significant is significant for the CO2 and EFPI estimates, indicating that financial depth in the economy (measured as the ratio of M2 to GDP) has a significant long-term impact on environmental degradation in terms of direct carbon emission and ecological footprint in the SSA region. The coefficient of LLR however fails the significance in the EFPC result. This shows that financial depth of financial liquidity in the economy does not significantly influence ecological footprint on cropland in the

long run. The coefficient of LLR is negative in both the CO2 and EFPI estimates, demonstrating that financial liquidity has a negative long-run effects on the two forms of environmental degradation. A rise in the financial depth of an economy leads to significant reduction in both CO2 emission and the ecological footprint of the economies. Thus, financial depth tends to act as a useful tool for enhancing environmental sustainability among SSA countries. The coefficient of stock market capitalization to GDP ratio (MKT), or the depth of the stock market is significant and negative for the CO2 and EFPC estimates. These results show that stock market depth leads to significantly reduction in both CO2 emission and ecological footprint decline in cropland for the countries.

On the other hand, the coefficient of MKT is significant and positive in the EFPI estimates, indicating that the depth of the stock market leads to increased ecological footprint in the built areas among SSA countries. The coefficient of stock market returns (SMT) also passes the significance test at the 1 percent level in each of the estimates. The coefficient is however negative in both of the ecological footprint estimates but positive in the CO2 estimates. This result indicates that the liquidity of the stock market significantly contributes to CO2 emission among SSA countries, while it equally leads to decline in ecological footprint. The results therefore show that although the financial development variables exerted limited effects on environmental degradation in the short run, the long run effects are significant and robust across all measures of financial development or environmental degradation. There are also certain levels of divergence in terms of the effects of financial development on environmental degradation when directly measured by the amount of Co2 emission and when indirectly measured as ecological footprint.

For the other control variables, the coefficient of GDP per capita is significant and positive in the CO2 and EFPC estimates, indicating that economic growth generally generates increases in environmental degradation in the long run. The coefficient of electricity consumption per capita is also positive and significant in the CO2 estimates, also indicating that energy consumption has spurred intensity of environmental degradation. The coefficient of energy consumption is however negative in the EFPI estimates, suggesting that energy consumption in cities appears to be more sustainable in the long run. The coefficient of urban rate is also positive and significant in two of the equations, which shows that increased urbanization is pushing the environment quite significantly. The negative coefficients of school enrolment in the estimates indicates that higher educational attainment leads to reduction in environmental degradation in the long run among SSA countries.

In order to demonstrate the robustness of the dynamic estimates in the panel mean group (PMG) estimations, the relationships are estimated for the individual countries using the ARDL and the long run results are reported in Table 4.9b. The CPS coefficient is significant for all the countries, except South Africa. Moreover, only Kenya did not have a significant LLR coefficient, while the coefficient of MKT is significant and mostly negative for all the countries except Ghana, Namibia and South Africa. The coefficient of SMT is also mostly significant and negative in the coefficients. These individual country estimates indicate that the financial development factors significant affect environmental degradation at the individual country levels, thus confirming the robustness of the PMG estimates reported earlier.

Table 4.9b: Individual Country Long Run Results

Variable	*Cote d'Ivoire*		*Ghana*		*Kenya*		*Mauritius*		*Namibia*		*Nigeria*		*South Africa*	
	Coeff.	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
CPS	0.082	0.022	-0.132	0.039	-0.057	0.021	-0.022	0.000	0.074	0.012	-0.019	0.020	0.001	0.719
LLR	-0.079	0.038	0.097	0.026	0.034	0.115	-0.004	0.442	-0.048	0.016	0.004	0.617	-0.005	0.046
MKT	-1.099	0.023	0.297	0.527	-0.203	0.009	-0.092	0.001	-0.049	0.854	-0.042	0.045	0.000	0.835
SMT	0.128	0.049	-0.208	0.016	0.069	0.013	0.032	0.018	0.033	0.012	0.010	0.104	0.000	0.995
LGDPPC	-2.113	0.106	4.138	0.136	2.988	0.081	-5.737	0.005	-1.151	0.138	-0.611	0.037	-1.563	0.179
LENC	0.798	0.323	-0.747	0.535	-3.227	0.010	0.612	0.027	-0.050	0.744	1.030	0.001	1.719	0.036
FDI	0.348	0.053	-0.171	0.006	0.081	0.031	0.001	0.933	-0.073	0.043	0.006	0.735	0.010	0.282
URB	0.335	0.258	0.850	0.001	2.143	0.016	-5.698	0.001	-0.032	0.395	-0.035	0.509	0.562	0.175
SER	0.717	0.937	-26.90	0.002	-15.003	0.027	-16.42	0.013	4.381	0.092	1.776	0.275	-0.071	0.565
Constant	16.869	0.069	1.048	0.893	17.428	0.155	341.2	0.007	17.095	0.047	16.09	0.000	-0.252	0.200

Source: Author's computation (2024)

4.4.2 Test of the Kuznets Hypothesis

Another objective of this study is to determine the presence or otherwise of the Kuznets hypothesis regarding economic performance and environmental degradation among SSA countries. It should be noted that the Kuznets curve proposes a parabola in germs 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 Table 4.10, the result for the Kuznets hypothesis for CO2 emission and ecological footprint are presented for both short run and long run.

Table 4.10: Results for Testing Kuznets Hypothesis

Variable	*LCO2*			*EFPC*			*EFPI*		
	Coeff.	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**
Long Run Equation									
LGDPPC	254.7	8.540	0.00	24.08	2.995	0.00	-303.6	-10.266	0.00
LGDPPC2	32.06	8.489	0.00	2.957	2.880	0.00	39.31	10.338	0.00
LGDPPC3	-1.337	-8.434	0.00	-0.121	-2.783	0.01	-1.690	-10.436	0.00
LENC	0.921	7.119	0.00	-0.026	-1.259	0.21	-0.022	-0.365	0.72
URB	0.019	2.810	0.01	-0.005	-1.304	0.20	0.058	4.737	0.00
FDI	-0.014	-1.670	0.10	0.006	3.623	0.00	0.039	9.051	0.00
SER	0.105	1.477	0.14	0.167	1.845	0.07	-0.038	-0.196	0.84
Short Run Equation									
ECM_{t-1}	-0.517	-2.864	0.00	-0.887	-5.399	0.00	-0.560	-2.739	0.01
$\Delta LGDPPC$	1572.2	2.178	0.03	1968.1	0.838	0.40	2380.5	0.851	0.40
$\Delta LGDPPC_{t-1}$	--	--	--	-1385.2	-1.508	0.13	806.6	0.925	0.36
$\Delta LGDPPC^2$	-206.3	-2.159	0.03	-227.9	-0.830	0.41	-278.8	-0.844	0.40
$\Delta LGDPPC^2_{t-1}$	--	--	--	169.1	1.588	0.12	-86.74	-0.818	0.42
$\Delta LGDPPC^3$	9.043	2.137	0.03	8.816	0.825	0.41	10.996	0.846	0.40
$\Delta LGDPPC^3_{t-1}$	--	--	--	-6.903	-1.679	0.10	3.076	0.709	0.48
Mean dep. var	0.037								
S.E. of reg.	0.096								

Source: Author's computation (2024)

However, only the long run estimates provide stable coefficients that are reliable for testing the hypothesis. In the result, the coefficient of the level economic growth variables (LGDPPC) is positive for both the CO2 and EFPC estimates. This shows that economic growth directly increases environmental degradation. The coefficient of LGDPPC further increases when the variable is raised to power two, which shows that intensified and higher levels of economic activities lead to increase of CO2 emission and ecological footprint for cropland among the countries, further hurting the environment. The coefficient of LGDPPC however changes to negative when the variable is raised to the power of three. This clearly shows that at very high levels of economic performance or income levels of citizens, economic growth begins to lead to lesser environmental hazards and degradation. At this high levels, environmental sustainability begins to play critical roles in the economic landscape. Thus, an inverted U-shape relationship is observed between long run economic growth and both CO2 emission and ecological footprint on cropland for the selected SSA economies.

The result for the estimates for ecological footprint in the built area (EFPI), the long run relationship is slightly different. At levels, LGDPPC has a negative effect on EFPI, indicating that at low levels of economic growth is usually better-off. The coefficient of the second power of the LGDDPC variable is positive and shows that a higher level of economic growth leads to increased environmental degradation for the economies. At very high levels of economic growth, indicated by the third power of the LGDPPC variable, growth again begins to exert negative effects on economic growth among the countries. Thus, the results show slight variations in the Kuznets curve narrative for SSA countries in line with different measures of environmental degradation.

4.4.3 Causality Between Financial Development and Environmental Degradation

The causality test is also conducted to determine the direction of cause-effect relationship between financial development, economic growth and environmental degradation. The Granger Panel causality test… is employed in the analysis of causality. The test is based on the estimates of W-statistics that are tested based on the Z-bar distribution. The results of the causality tests are presented in Table 4.11. In the result, the coefficient of causality not running from CO2 to CPS is significant at the 1 percent level, and the coefficient of the reverse null hypothesis is also significant at the 1 percent level. This implies that there is reverse causality running between CO2 emission to credit development in the economy. A similar result is found for the causality between LLR and Co2 emission. Thus, for the two money market variables indicate that they explain variations in CO2 emission, and the level of emissions also stimulate these financial market variables.

Table 4.11: Causality Test Result

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
MKT does not homogeneously cause LCO2	0.980	-1.332	0.183
LCO2 does not homogeneously cause MKT	3.200	1.144	0.253
SMT does not homogeneously cause LCO2	2.364	0.212	0.832
LCO2 does not homogeneously cause SMT	2.434	0.290	0.772
CPS does not homogeneously cause LCO2	5.996	3.917	0.000
LCO2 does not homogeneously cause CPS	7.069	5.460	0.000
LLR does not homogeneously cause LCO2	4.175	2.002	0.041
LCO2 does not homogeneously cause LLR	5.130	3.298	0.001
MKT does not homogeneously cause EFPC	4.239	2.303	0.021
EFPC does not homogeneously cause MKT	3.738	1.744	0.081
SMT does not homogeneously cause EFPC	4.715	2.172	0.042
EFPC does not homogeneously cause SMT	3.248	1.198	0.231
CPS does not homogeneously cause EFPC	5.470	3.676	0.000
EFPC does not homogeneously cause CPS	1.067	-1.234	0.217
LLR does not homogeneously cause EFPC	6.781	5.139	0.000
EFPC does not homogeneously cause LLR	2.183	0.010	0.992
LCO2 does not homogeneously cause LGDPPC	3.427	1.398	0.162
LGDPPC does not homogeneously cause LCO2	6.513	4.840	0.000
EFPC does not homogeneously cause LGDPPC	2.740	0.631	0.528
LGDPPC does not homogeneously cause EFPC	8.331	6.868	0.000
EFPI does not homogeneously cause LGDPPC	3.061	0.990	0.322
LGDPPC does not homogeneously cause EFPI	12.161	11.140	0.000

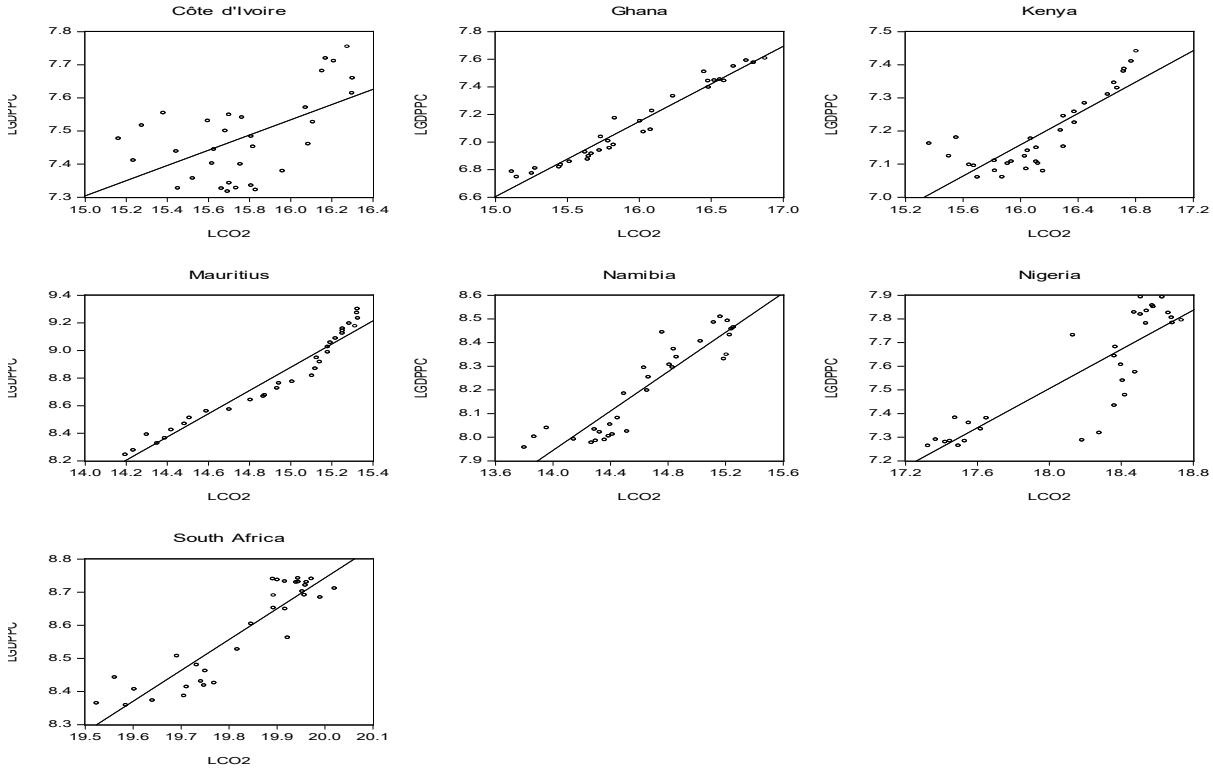
Source: Author's computation (2024)

There is no significant level of causality between the stock market variables and CO2 emission in the results shown in Table 4.11, although the results also show that there is a high level of unidirectional causality running from the stock market variables and environmental degradation measured by ecological footprint. The result also shows that a significant unidirectional causality also exists with causality running from both CPS and LLR to the two ecological footprint variables. Thus, the results generally show that long run causality essentially flowed from either economic growth or financial development to environmental degradation while the reverse causality was minimal.

4.4.4 The Moderating Role of Financial Development in the Economic Growth and Environmental Degradation Relationship

Finally, the last objective of the study is considered in terms of the role of financial development in influencing the relationship between economic growth and environmental degradation in SSA countries. The interaction estimation procedure is employed to demonstrate the hypothesised moderating roles of the financial development variables in the relationship between economic growth and environmental degradation among the SSA countries. The presence of a moderating effect can be easily tested in a scatterplot showing the relationship between economic growth and environmental degradation for the individual countries. The scatterplots presented in Figure 4.9 report that the relationship between economic growth and environmental degradation (measured as CO2) are different among the countries, although the relationship is generally positive. The slope of the relationship is steeper for South Africa, Namibia, and Nigeria, while the slope is flatter for CIV, Ghana and Kenya. Given that South Africa is the most financially developed country and Ghana is the least, developed country in the sample, the chart suggests that the effects of economic growth on environmental degradation is different on the basis of the level of

financial development of a country. This relationship in the scatterplot provides the ground for estimating the interaction model to show how financial development influences the impact of economic growth on the environment.



The results of the estimated interaction terms model for evaluating the influence of financial development in the relationship between economic growth and environmental degradation are presented in Table 4.12. Only the long run estimates are also reported in this case since these estimates present the stable relationships among the variables. Moreover, the estimates are conducted for CO2 emission since this variable represents the direct component of environmental degradation. The focus in the estimates is particularly on the coefficients of the interaction terms. In the results, the interaction between CPS and economic growth yields a negative coefficient of -0.008, suggesting that the impact of economic growth on environmental degradation is lesser by 0.08 percentage points for countries with higher credit to GDP ratio.

Note that the coefficient of LGDPPC is positive and significant in the estimate. Thus, the result clearly shows that countries with higher credit market development tend to experience a lesser impact of economic growth on the environment.

Table 4.12: Result for the Moderating Role of Financial Development

Variable	*Interaction variables*							
	CPS		*LLR*		*MKT*		*SMT*	
	Coeff.	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
LGDPPC	0.921	0.00	-0.435	0.01	0.501	0.02	0.283	0.19
CPS	0.053	0.06						
*CPS*LGDPPC*	-0.008	0.02						
LLR			-0.047	0.04				
*LLR*LGDPPC*			0.005	0.04				
MKT					0.364	0.37		
*MKC*LGDPPC*					-0.057	0.04		
SMT							-0.075	0.33
*SMT*LGDPPC*							0.009	0.33
LENC	0.187	0.01	1.697	0.00	0.278	0.00	0.211	0.00
FDI	0.000	0.97	0.020	0.05	-0.005	0.51	0.004	0.62
URB	0.050	0.00	0.032	0.00	0.006	0.39	0.019	0.00
SER	-0.039	0.91	0.218	0.27	1.269	0.00	1.008	0.01
Mean dep. var	0.037		0.038		0.037		0.037	
S.E. of reg.	0.099		0.091		0.099		0.101	

Source: Author's computation (2024)

The result for the interaction term with LLLR in the second column indicates that the coefficient of the interaction term is 0.005 and is positive at the 5 percent level. This coefficient indicates that the negative impact of economic growth in tempered for countries with larger overall financial depth. The third column of the result shows the shows the effect of the interaction between economic growth and stock market depth on environmental degradation. The coefficient of economic growth in the estimation is positive and insignificant. The coefficient of the interaction terms is however negative and also significant at the 5 percent level. This shows that stock market development has a significant negative influence on the relationship between

economic growth and environmental degradation among SSA countries. Specifically, the debilitating impact of economic growth on the environment is lower in countries with more developed capital market. Thus, stock market development is shown to act as a shield for mitigating the effect of economic activities on environmental degradation for the countries. The result for the interaction term with stock market returns indicates that the coefficient of the interaction term is not significant even at the 5 percent level. Thus, there is no evidence that stock market returns influence the effect of economic growth on environmental degradation among the countries in the study.

4.5 Robustness Test for 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 financial development variables are measures of the dimension of the financial markets in the respective 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 4.13, 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 4.13, 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 4.13: Post Estimation Test Results – Multicollinearity test

Variable	LCO2	EFPC	EFPI
CPS	0.968	1.012	0.746
LLR	0.435	0.455	0.785
MKT	0.341	0.356	0.615
SMT	0.444	0.464	0.801
LGDPPC	0.609	0.636	1.098
LENC	0.395	0.413	0.712
URB	2.859	2.988	0.157
FDI	4.824	4.041	1.701
SER	2.038	2.130	0.676

Source: Author's computations (2024)

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 4.10) 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.

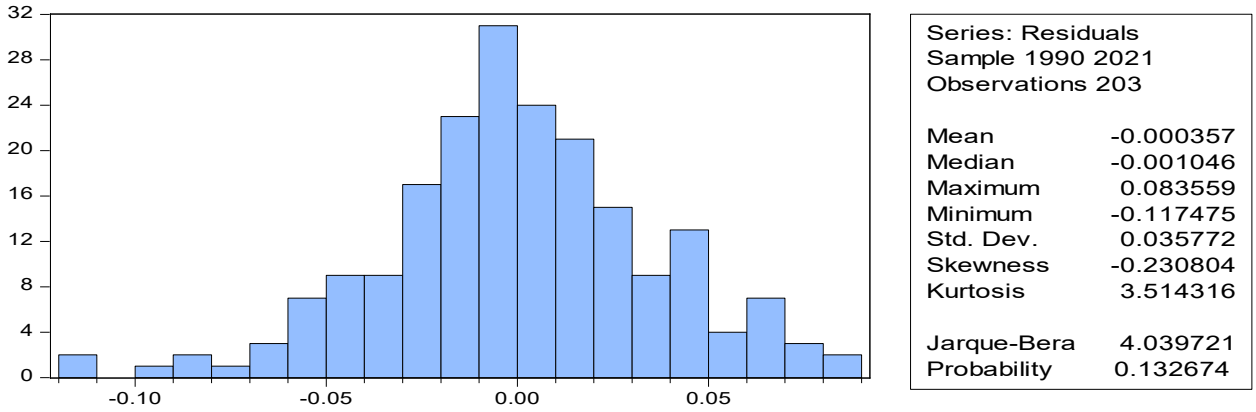


Fig. 4.10: Test for Normality of Residual Estimates

4.5 Test of Hypotheses

In this section, the working hypotheses that were formulated for the study are empirically tested. The 5 percent significance level is selected for conducting the test.

Hypothesis One

Credit to private sector has no significant effect on environmental degradation in selected Sub-Saharan African countries

The test of the first four hypotheses of the study is based on the long run stable estimates of the relationship between financial development and environmental degradation that are reported in Table 4.9a. The hypothesis tests are conducted across the three dependent variables in the study. In the result, the coefficient of CPS is not significant in the CO2 Equation but passes the significance test in the EPFC and EFPI Equations at the 5 percent level (i.e., $P < 0.05$). Since CPS is significant in two of the three estimations, the null hypothesis is rejected in this case, which implies that credit to private sector a significant effect on environmental degradation in selected Sub-Saharan African countries. The effect is positive or negative based on the measure of environmental degradation considered.

Hypothesis Two

Broad money supply to gross domestic product has no significant effect on environmental degradation in selected Sub-Saharan African countries

The test of the second hypothesis is based on the coefficient of LLR in the results in Table 4.9a. In the result, the coefficient of LLR passes the significance test in the CO2 emissions and EFPI Equations at the 5 percent level (i.e., $P < 0.05$). Thus, LLR is significant in two of the three estimations. This means that the null hypothesis can be rejected in this case. Thus, it is shown that broad money supply to gross domestic product has a significant negative effect on environmental degradation in selected Sub-Saharan African countries.

Hypothesis Three

Market capitalization to gross domestic product has no significant effect on environmental degradation in selected Sub-Saharan African countries

In order to test this hypothesis, the coefficient of MKT in the results in Table 4.9a is considered. The coefficients are all significant in each of the three measures of environmental degradation at least at the 5 percent level ($p < 0.05$). Based on this outcome, the null hypothesis is rejected. This indicates that market capitalization to gross domestic product actually has a significant effect on environmental degradation in selected Sub-Saharan African countries, with the effect on CO2 emission being negative.

Hypothesis Four

Stock market turnover ratio has no significant effect on environmental degradation in selected Sub-Saharan African countries

The coefficient of SMT in the result in Table 4.9a passes the significance test at the 5 percent level in each of the Equations. Thus, the null hypothesis is rejected in this case, indicating that

stock market turnover ratio has a significant effect on environmental degradation in selected Sub-Saharan African countries.

Hypothesis Five

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

The test of the fifth hypothesis is performed by considering the estimations in Table 4.10. In the stable long run results, the coefficients of the variables used to measure the environmental Kuznets curve hypothesis (*LGDPPC*, $LGDPPC^2$, and $LGDPPC^3$) are all significant at the 5 percent level. The null hypothesis is therefore rejected, which implies that the environmental Kuznets curve hypothesis (EKC) exists in the selected Sub-Saharan African countries.

Hypothesis Six

Financial system development does not Granger-cause environmental degradation; economic growth does not Granger-cause environmental degradation in selected Sub-Saharan African countries or Environmental degradation does not Granger-cause financial system development; environmental degradation does not Granger-cause economic growth in the selected Sub-Saharan African countries

The test of this hypothesis is based on the Causality Test reported in Table 4.11. In the causality tests, there is significant reverse and unidirectional causality between financial development variables and environmental degradation, and unidirectional causality was also significantly tested for the relationship between economic growth and environmental degradation. In each test, the coefficients pass the significance test at the 5 percent level ($p < 0.05$. Thus, the null hypothesis is rejected in this case.

Hypothesis Seven

Financial development does not influence the relationship between economic growth and environmental degradation in selected Sub-Saharan African countries

The test of the hypothesis is based on the estimates of the interaction terms in the results reported in Table 4.12. Four the four interaction terms, those involving CPS, LLR, and MKT were all significant at the 5 percent level. Thus, the null hypothesis can be rejected in this case, implying that financial development actually exerts significant influences on the relationship between economic growth and environmental degradation in selected Sub-Saharan African countries.

4.6 Discussion of Results

The findings of this study are discussed in this section. Firstly, the study found that financial sector development significantly affects environmental degradation in SSA countries. The predominant effects were found to be negative both on CO2 emissions and on ecological footprints. In particular, the effects of money market related factors of credit ratio and financial liquidity in the economy were found to be similar to the effects of stock market related factors, although the effects of the money market-related factors were found to be more profound. These results are similar to findings by Zaidi et al (2019), Majeed and Maria (2019), Habiba and Xinbang (2022), and Aljadani (2022). The results imply that the deepening of the financial system has the capacity to filter investment and consumption activities that hurt the environment. Thus, financial development appears to be a unique structural transformation patterns among SSA countries with the capacity of upscaling social and economic patterns and aligning them with more sustainable patterns. The financial sector development therefore appears to be the main source of economic sustainability among SSA countries.

Other previous studies have however found interjecting results from the current studies. For instance, some studies found that financial development actually increase environmental degradation in a country (Shahbaz et al, 2020; Ibrahim & Vo, 2021). Certain aspects of this current study appear to be in line with these findings, although it is demonstrated that the positive impacts are not unequivocal. Other studies have found that effects of financial development on environmental degradation are essentially limited (Li & Ouyang, 2019). In general, different findings may appear to highlight different measures of either financial development factors or aspects of environmental degradation.

In addition, the findings from the study indicated that the intensity of effects of financial sector development on environmental degradation differs between the short run and the long run. In particular, the long run effects were shown to be more direct and sustainable than the patterns of short run effects. The finding of divergent dimension of impact of financial development factors on environmental development also appears to align previous studies like Longe et al (2020), Lestari et al (2020), and Naimo (2022).

This study also proved the existence of an environmental Kuznets curve hypothesis for the selected SSA countries. The results show that for CO2 emission, the Kuznets curve is a higher-order parabola where the positive impact of economic growth on the environmental degradation is only felt at very high levels of economic activities. This result is plausible for SSA countries given the very low degree of economic size among the countries. Shahbaz et al (2021) however found that there could be more than one turning points which seems to align with our current findings. This is also shown in this study in relation to the Kuznets curve hypothesis for ecological footprint.

The results of the causality test generally showed that long run causality essentially flowed from either economic growth or financial development to environmental degradation while the reverse causality was minimal. This aligns with previous findings by Musa, et al (2021), Longe et al (2020), and Emir and Bekun (2019). This result implies that it is the level of financial and economic development that stimulates changes in environmental degradation, but environmental degradation does not stimulate changes in economic and financial development in a meaningful way. The result suggests two dimensions of effects among financial development, economic growth and the environment. It shows that the direction of economic growth and financial development can be used to determine the level of environmental degradation in the country. This is a positive outcome that implies that structural and economic policies can be used to influence the direction of environmental degradation by making adjustments in the system. The results however also indicate that the level of environmental degradation to not stimulate changes in financial development or economic growth among the SSA countries. This outcome of the result is negative since it shows that environmental degradation is not currently being considered as an effective input in the direction of the economic and financial

CHAPTER FIVE

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Summary of Findings

The effects of climate change and the attendant degradation of the environment have become entrenched in both policy and research agenda across the globe. There are clear concerns that different segments of the economy have historically contributed to the weakening of climate systems and these economic components need to be redirected to ensure long run sustainability for the environment. In this study the relative effects of financial development and economic growth on environmental degradation in selected Sub-Saharan African (SSA) countries is examined. In particular, the study considered the roles of different financial system development factors on the environment, while also examining the impacts of economic growth on the environment using the environmental Kuznets curve (EKC) formulation. The direction of causality among the main variables in the study was also evaluated in the study, while claiming the depth of financial development can aid in mitigating any negative effects of economic activities on the environment among the SSA countries.

In the study, environmental degradation is measured in terms of the tonnes of carbon emission per country and the rate of ecological footprint per capita. Financial system development is measured using both the money and capital markets indicators, including credit to the private sector, liquidity in the economy (M2 to GDP ratio), market capitalization to GDP ratio, and stock market turnover (to measure stock market liquidity). Moreover, data used included seven (7) selected sub-Saharan African countries over the period of 1990 to 2021. 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. The main finding of the study reveals that financial development matters for the pattern of environmental degradation in a country. Specifically, the following findings were made:

1. That the ratio of private sector credit to gross domestic product has a significant impact on environmental degradation in selected Sub-Saharan African countries. The effects are however long run, rather than short run.
2. That broad money supply to gross domestic product has a significant long run effect on environmental degradation in selected Sub-Saharan African countries. The short run effect is however insignificant.
3. That market capitalization to gross domestic product ratio has a significant long run impact on environmental degradation in selected Sub-Saharan African countries. Market capitalization is shown to reduce carbon emissions by SSA countries, but increase the ecological footprint of the countries.
4. That stock market turnover ratio significantly affects environmental degradation in selected Sub-Saharan African countries in the long run. Market turnover reduces carbon emissions, but increases ecological footprints of the countries.
5. That a significant environmental Kuznets curve hypothesis (EKC) exists in the long run for the selected Sub-Saharan African countries.
6. That a unidirectional causation exists between financial system development and environmental degradation in SSA countries, with financial development predominantly stimulating variations in environmental degradation. A unidirectional causation that runs from economic growth to environmental degradation in selected Sub-Saharan African countries is also established.

7. That financial development mitigates the negative effects of economic growth on environmental degradation among the selected Sub-Saharan African countries.

5.2 Recommendations

The results of the study on financial development and environmental degradation provide basic grounds for proffering recommendations both for policy and practice. The result of the study has shown that financial development has the capacity to reduce environmental degradation among SSA countries. This implies that the sector needs to be further developed and streamlined to guide sustainable practices. The money market should focus on financing environmentally friendly projects that can limit the degradation of the environment. Also, the capital market needs to develop bonds that are pro-climate change agenda in order to guide the orientation of investors into more sustainable investment activities in the economies.

The study also found that the money market-related variable of credit depth is more profound in mitigating environmental degradation than the stock market-related variables of stock market capitalization rate and stock market turnover. Thus, the focus of policy, especially in the short run, should be on the money market activities as a major driver of sustainable economic activities. Banks, in particular, needs more advanced tools of regulation that will include mandates on environmental sustainability of their loan and credit policy. This will help improve the contribution of the money market in reducing environmental degradation.

Furthermore, the study found that the long run effects of financial development on environmental degradation is different from the long run effects, especially in the depth of the effects. The short run effects are minimal and sporadic, while the long run impacts are deep and effective. Thus, policy makers need to consider the financial sector in its long term environmental and climate

planning over time. This consideration will ensure that the unique capacity of the financial markets within the structural setup of the economy can be leveraged on in terms of managing the environment among SSA countries.

Moreover, the results of the study generally showed that long run causality essentially flowed from either economic growth or financial development to environmental degradation while the reverse causality was minimal. Thus, the financial markets need to put in place mechanisms to ensure that the markets respond directly to the level of environmental degradation in the system by market adjustment patterns like the loan system (more green loans), bonds being created and commitment of investors to ensuring sustainable practices.

The results from the empirical analysis that the environmental Kuznets curve hypothesis actually holds for SSA countries. This is throws up the important issue of variables to be considered in estimating this hypothesis. This result portends important policy considerations among SSA countries. The result shows that the region may successfully tackle environmental degradation challenges by following similar patterns of that more advanced economies have taken given that the EKC is the same pattern that the growth-environment relationship has thrived among the advanced economies.

Finally, the estimations from the study show that the addressing environmental degradation is a long-term issue that requires strong and persistent actions. Thus, every policy action taken by SSA countries must consider the long run implications and applicability in every segment of the economies. It will be inefficient to adopt short term policies in addressing environmental issues by SSA countries since such policies may not produce the desired long-term effect that is necessary to reduce degradation over time.

5.3 Conclusion

Curbing environmental degradation is crucial in ensuring that the gains from growth and development in the economy as well as human well-being are sustainable in the long term and are not terminated abruptly. Thus, environmental considerations are key in the setting of national and global reform priorities in every sector of the economy. In this study the role of financial sector development in directly limiting environmental degradation or indirectly influencing the effect of economic activities on the environment was examined. There is evidence that financial development is crucial not only in directly addressing environmental degradation, but also in mitigating economic actions on the environment. Essentially, financial sector appears to be holding a more and more critical key for entrenching sustainability in the economic system of SSA countries. Since this sector is usually the most advanced in both developing and emerging economies like those of SSA countries, financial markets need to take the lead in ensuring environmental sustainability for countries in the region. This will be the most efficient and effective means of rapidly and profoundly addressing the future disaster that may occur if the environment is left unattended in the next few years.

5.4 Contributions to Knowledge

This study made contribution to knowledge in the following ways:

1. By focusing on different aspects of financial system development (including both money and capital markets), the study offered a distributional evaluation of the financial system as a net contributor to environmental degradation. Thus, the further extends the literature on the relative roles of continued deepening of the money market versus the capital market on the environment among SSA countries.

2. The study extended knowledge on the environmental Kuznets curve (EKC) by applying (i) applying a time-varying framework using the PMG for SSA countries, (ii) by examining the roles of hyper-development in the EKC formulation. This is an extension 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 financial development and the environment, (iii) possible interactions between the financial system and economic 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 financial sector development and environmental degradation among SSA countries. There are areas that have not been fully touched which constitute areas for further research.

1. First, the study has considered financial development in terms of overall depth of the financial system as well as in relation to money and capital markets. However there are other important areas where the financial system plays important roles in influencing climate actions which was not the focus of this study. Further research is therefore required to explore other areas of the financial markets that contribute to this relationship, especially the ones that are particular to banks, which have been found to hold an important key to environmental actions among SSA countries. In particular, further

research is required in areas of interest rate policy of banks as tool for promoting environmental accountability in the system.

2. There is also need for further research in the estimation of the environmental Kuznets curve hypothesis to determine the specific variables in environmental degradation that fully support the hypothesis among SSA countries.

REFERENCES

Aboagye, S. (2017). Economic expansion and environmental sustainability nexus in Ghana. *African Development Review, 29*(2), 155–168. doi: 10.1111/1467-8268.12247

Acaravci, A., & Ozturk, I. (2010). On the relationship between energy consumption, CO_2 emissions and economic growth in Europe. *Energy, 35*(12), 5412 - 5420.

Acheampong, A. O., Adams, S., & Boateng, E. (2019). Do globalization and renewable energy contribute to carbon emissions mitigation in Sub-Saharan Africa? *Science of the Total Environment, 677*, 436–446. https://doi.org/10.1016/j.scitotenv.2019.04.353

Adegbite, E. S. (2008). Towards vision 2020: Another look at financial development and economic growth nexus in Nigeria. *Journal of Banking, Finance and Economics, 2*(1), 27 – 49.

Aduebe, C. J. (2013). An empirical test of environmental Kuznets curve in Nigeria. Unpublished M.Sc thesis, Department of Economics, Faculty of the Social Sciences, University Of Nigeria, Nsukka, Enugu State).

Adzawla, W., Sawaneh, M., & Yusuf, A. M. (2019). Greenhouse gasses emission and economic growth nexus of sub-Saharan Africa. *Scientific African, 3*, e00065. https://doi.org/10.1016/j.sciaf.2019.e00065

Aigbovo, O. (2013). Financial system development and economic growth in Nigeria. Unpublished M,Sc thesis submitted to the Department of Banking and Finance, University of Benin.

Ajayia, P.I. & Ogunrinola, A. O. (2020). Growth, Trade openness and environmental degradation in Nigeria. MPRA Paper No. 100713. Online at https://mpra.ub.uni-muenchen.de/100713/

Akbostancı E., Türüt-Aşık, S., & Ðpek-Tunç, G. (2009). The relationship between income and environment in Turkey: Is there an environmental Kuznets curve? *Energy Policy, 37*, 861-867.

Akinlo, A.E., & Owoyemi, B.O. (2012). The determinants of interest rate spread in Nigeria: An empirical investigation. *Modern Economy, 3*, 837-845.

Al Sayed, A. R. M., & Sek, S. K. (2013). Environmental kuznets curve: evidences from developed and developing economies. *Applied Mathematical Science, 7*(22), 1081-1092.

Al Shubiri, F.N., & Jamil, S.A. (2017). Accessing the determinants of interest rate spread of commercial banks in Oman: An empirical investigation. *European Research Studies Journal, XX*(2A), 90-108

Alabi, M.K., Ojuolape, M.A., & Yaqoob, J. (2021). Economic growth and environmental degradation nexus in Sri Lanka. *Sri Lanka Journal of Social Sciences and Humanities, 1*(2), 135-145.

Alam, M. M., Murad, M. W., Noman, A. H. M., & Ozturk, I. (2016). Relationships among carbon emissions, economic growth, energy consumption and population growth: Testing environmental Kuznets curve hypothesis for Brazil, China, India and Indonesia. *Ecological Indicators, 70*(2016), 477-479. https://doi.org/10.1016/j.ecolind.2016.06.043

Alege, P. O., & Ogundipe, A. A. (2016). Environmental quality and economic growth in Nigeria: A fractional cointegration analysis. *International Journal of Development and Sustainability, 2*(2), 580 - 596. https://isdsnet.com/ijds-v2n2-10.pdf

Alexandra, T. (2021). Volume of trade. htttps://www.investopedia.com/terms/v/volumeof trade.asp.

Aljadani, A. (2022). Assessment of financial development on environmental degradation in KSA: how technology effect? *Environmental Science and Pollution Research, 29*(3), 4736-4747. https://doi.org/10.1007/s11356-021-15795-1.

Al-Mulali, U., Saboori, B., & Ozturk, I. (2015). Investigating the environmental Kuznets curve hypothesis in Vietnam. *Energy Policy, 76*(2), 123 – 131. doi: 10.1016/j.enpol.2014.11.019.

Al-Mulali, U. & Sheau-Ting, L. (2014). Econometric analysis of trade, exports, imports, energy consumption and CO2 emission in six regions. *Renewable and Sustainable Energy Reviews, 33*, 484 – 98.

Al-Mulali, U., & Ozturk, I. (2016). The investigation of environmental Kuznets curve hypothesis in the advanced economies: the role of energy prices. *Renewable Sustainable Energy Reviews, 54*(C), 1622 - 1631. http://doi: 10.1016/j.rser.2015.10.131.

Andreoni, J., & Levinson, A. (2001). The simple analytics of the environmental Kuznets curve. *Journal of Public Economics, 80*, 269-286.

Arouri, M., Shahbaz, M., Onchang, R., Islam, F., & Teulon, F. (2013). Environmental Kuznets curve in Thailand: Cointegration and causality analysis. *The Journal of Energy and Development, 39*(1/2), 149-170.

Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, CS., Jansson, B. O., Levin, S., Mäler, K. G., Perrings, C. A., & Pimentel, D. (1995). Economic growth, carrying capacity, and the environment. *Science Series, 268*, 520-21.

Asghari, M. (2013). Does FDI promote MENA region's environment quality? Pollution halo or pollution haven hypothesis. *International Journal of Scientific Research in Environmental Sciences, 1*(6), 92-100.

Aslan A, Destek, M. A, Okumus I. (2018). Bootstrap rolling window estimation approach to the analysis of the Environment Kuznets Curve hypothesis: evidence from the USA. *Environmental Science Pollution Research, 25*(3), 2402–2408. doi: 10.1007/s11356-017-0548-3.

Astri, S. (1993). Pressure point: Environmental degradation and migration conflict. A paper presented at the workshop on environmental change, Population displacement, and Acute Conflict, held at the Institute for Research on Public Policy in Ottawa.

Aufderheide, P., & Rich, B. (1988). Environmental reform and the multilateral banks. *World Policy Journal, 5*(2), 301-321.

Awad, A., & Warsame, M. H. (2017). Climate changes in Africa: Does economic growth matter? A semi-parametric approach. *International Journal of Energy Economics and Policy, 7*(1), 1 – 8.

Awodumi, O.B., & Adewuyi, A.O. (2020). The role of non-renewable energy consumption in economic growth and carbon emission: Evidence from oil producing economies in Africa. *Energy Strategy Review, 27*, 10 - 34.

Aydin, C., Esen, Ö., & Aydin, R. (2019). Is the ecological footprint related to the Kuznets curve a real process or rationalizing the ecological consequences of the affluence? Evidence from PSTR approach. *Ecological Indicators, 98*, 543-555.

Ayeche, M. B., Barhoumi, M., & Hammas, M. A. (2016). Causal Linkage between Economic Growth, Financial Development, Trade Openness and CO2 Emissions in European Countries. *American Journal of Environmental Engineering, 6*(4), 110 - 122. doi: 10.5923/j.ajee.20160604.02.

Ayompe, L. M., Davis, S. J., & Egoh, B. N. (2020). Trends and drivers of African fossil fuel CO_2 emissions 1990–2017. *Environmental Research Letter, 15*(2020),1 - 12 DOI:10.1088/1748-9326/abc64f

Azam, M., Khan, H. N., & Khan, F. (2020). Testing Malthusian's and Kremer's population theories in developing economy. *International Journal of Social Economics, 47*(4), 523–538.

Aziakpono, M.J. (2008). The depth of financial integration and its effects on financial development and economic performance of the SACU countries. Unpublished PhD Thesis. University of Free State: Department of Economics.

Azomahou T., Laisney F., & P.N. Van (2006), Economic development and CO2 emissions: A nonparametric panel approach. *Journal of Public Economics 90*, 1347-1363.

Babatunde, O. (2014). Inclusive green growth in Africa: rationale, challenges and opportunities; United Nations Development Programme (UNDP) Policy Brief: Pretoria, South Africa, 3–11.

Bacon, R. W. & Bhattacharya, S. (2007). Growth and CO_2 emissions: how do different countries fare? Environment working paper series; No. 113. Washington, DC: World Bank.

Bah, M. M., Abdulwakil, M. M., & Azam, M. (2020). Income heterogeneity and the environmental Kuznets curve hypothesis in sub-saharan african countries. *Geo Journal, 85*(3), 617–628. https://doi.org/10.1007/s10708-019-09985-1

Baloch, M. A., Zhang, J., Iqbal, K., & Iqbal, Z. (2019). The effect of financial development on ecological footprint in BRI countries: Evidence from panel data estimation. *Environmental Science and Pollution Research, 26*(6), 6199-6208.

Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., & Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO2 emissions? *Energy Policy, 113*(2018), 356-367. https://doi.org/10.1016/j.enpol.2017.10.050

Beck, T., Demirguc-Kunt, A., Levine, R. & Maksimovic, V. (2000). Financial structure and economic development: Firm, Industry, and Country Evidence. *World Bank Policy Research Working Paper* No. 2423. Washington, DC: The World Bank.

Ben Jebli, M., Ben Youssef, S., & Ozturk, I. (2015). The role of renewable energy consumption and trade: environmental kuznets curve analysis for Sub-Saharan Africa countries. *African Development Review, 27*(3), 288–300. https://doi.org/10.1111/1467-8268.12147.

Bibi, F.; Jamil, M. (2021). Testing environment Kuznets curve (EKC) hypothesis in different regions. *Environmental Science Pollution Research, 28*, 13581–13594.

Boopen, S., & Vinesh, S. (2011). On the relationship between carbon emissions and economic growth: the Mauritian experience. Available from: http://www.csae.ox.ac.uk/conferences/2011-EDiA/papers/776-Seetanah.pdf

Bourque, C.P.A., Cox, R.M., Allen, D.J., Arp, P.A., & Meng, F.R. (2005). Spatial extent of winter thaw events in eastern North America: historical weather records in relation to yellow birch decline. *Global Change Biology, 11*(9), 1477-1492.

Boutabba, M. A. (2014). The impact of financial development, income, energy and trade on carbon emissions: Evidence from the Indian Economy. *Economic Modelling, 40*(4), 33 – 41. doi: http://dx.doi.org/10.1016/j.econmod.2014.03.005.

Brahmbhatt, M., Bishop, R., Zhao, X., Lemma, A., Granoff, I., Godfrey, N., & Te Velde, D. (2016). Africa's new climate economy: Economic transformation and social and environmental change; Supporting Econocim Transfoprmation: London, UK.

Brander, M. (2012). Greenhouse gases, CO_2, CO_2e, and carbon: What do all these terms mean? *Ecometrica,* 1 – 3. https://ecometrica.com/assets/GHGs-CO2-CO2e-and-Carbon-What-Do-These-Mean-v2.1.pdf

British Petroleum (2020). British petroleum statistical review of world energy 2020, 69th ed.; BP: London, UK, 1–63.

Brown, B. J., Hanson, M. E., Liverman, D. M. & Merideth, R.W. (1987). Global sustainability: toward definition. *Environmental Management, 11*(6), 713-719.

Burda, M., & Wyplosz, C. (2005). *Macroeconomics*, Oxford University press, New York, US.

Caporale, G. M., Claudio-Quiroga, G., & Gil-Alana, L. A. (2021). Analyzing the relationship between CO_2 emissions and GDP in China: a fractional integration and cointegration approach. *Journal of Innovation Entrepreneurship, 10*(32), 2 – 16. https://doi.org/10.1186/s13731-021-00173-5.

Carvalho, T. S., & Almeida, E. (2010). The hypothesis of the global Environmental Kuznets Curve: An econometric spatial perspective. *Estudos Econômicos, 40*(3), 587-615. www.ub.edu/sea2009.com/Papers/119.pdf accessed on 30/12/2013.

Central Bank of Nigeria (1993) in Samuel, M.N., & Emeka, J. O. (2009). Financial deepening and economic development of Nigeria: An empirical investigation. *African Journal of Accounting, Economics, Finance and Banking Research, 5*(5), 52-66

Chang, S. (2015). The effects of trade liberalization on environmental degradation, Quality & quantity. *International Journal of Methodology, Springer, 49*(1), 235-253.

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

Chikaraishi, M., Fujiwara, A., Kaneko, S., Poumanyvong, P., Komatsu, S., & Kalugin, A. (2015). The moderating effects of urbanization on carbon dioxide emissions: A latent class modeling approach. *Technological Forecasting and Social Change, 90*, 302-317.

Choi, E., Heshmati, A., & Cho, Y. (2010). An empirical study of the relationships between CO_2 emissions, economic growth and openness. (The Institute for the Study of Labor - IZA Discussion Paper Series No. 5304).

Chopra, R. (2016). Environmental degradation in India: Causes and consequences. International *Journal of Applied Environmental Sciences, 11*(6), (2016), 1593-1601

Climate Watch (2021). Climate Watch Data. Available online: https://www.climatewatchdata.org/ghg-emissions?breakBy=gas&chartType=percentage &gases=201&sectors=618%2C616%2C617%2C620%2C619 (accessed on 9 March 2021).

Commoner, B. (1972). The environmental cost of economic growth. In: Ridker, R.G. (ed.). Population, Resources and the Environment. United States Government Printing Office. Washington DC, 339 – 363.

Conserve Energy Future (2020). What is environmental degradation? https://www.conserve-energy-future.com/causes-and-effects-of-environmental-degradation.php.

Copeland B., & Taylor, M. S. (2004). International trade and the environment: a framework for analysis, (NBER Working Paper, No. 8540), Washington.

Dasgupta S., Laplante B., Wang H., & Wheeler D. (2002). Confronting the environmental Kuznets curve. *Journal of Economic Perspectives, 16*(1), 147 – 168.

De Bruyn, S. M., van den Bergh, J. C. J. M. & Opschoor, J. B. (1998). Economic growth and emissions: reconsidering the empirical basis of environmental Kuznets curves. *Ecological Economics, 25*, 161-175.

Demissew Beyene, S., & Kotosz, B. (2019). Testing the environmental Kuznets curve hypothesis: An empirical study for East African countries. *International Journal of Environmental Studies,* 1–19. https://doi.org/10.1080/00207233.2019.1695445

Destek, M. A., & Sarkodie, S. A. (2019). Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development. *Science of the Total Environment, 650*, 2483-2489. Available at: https://doi.org/10.1016/j.scitotenv.2018.10.017.

Dietz, T. & Rosa, E. A. (1997). Effects of population and affluence on CO2 emissions. *Proceedings of the National Academy of Sciences, 94*, 175-179.

Dogan, E., & Ozturk, I. (2017). The influence of renewable and non-renewable energy consumption and real income on CO_2 emissions in the USA: evidence from structural break tests. *Environmental Science Pollution Research 24*(2), 10846 – 10854. doi: 10.1007/s11356-017-8786-y

Dong, K., Sun, R., Jiang, H., & Zeng, X. (2018). CO2 emissions, economic growth, and the environmental Kuznets Curve in China: What roles can nuclear energy and renewable energy play? *Journal of Cleaner Production, 196*(2018), 51-63. https://doi.org/10.1016/j.jclepro.2018.05.271

Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics, 80*(4), 549-560.

Egbetokun, S., Osabuohien, E. S., Akinbobola, T., Onanuga, O., Gershon, O., & Okafor, V. (2019). Environmental pollution, economic growth and institutional quality: Exploring the nexus in Nigeria. AGDI Working Paper, No. WP/19/059, African Governance and Development Institute (AGDI), Yaoundé.

Ehrlich, P., & Holdren, J. (1970). The people problem. *Saturday Review, 4*, 42-43.

Emir, F., & Bekun, F. V. (2019). Energy intensity, carbon emissions, renewable energy, and economic growth nexus: New insights from Romania. *Energy and Environment, 30*(3), 14 – 28. https://doi.org/10.1177/0958305X18793108

Esteve, V., & Tamarit, C. (2012). Is there an environmental Kuznets curve for Spain? Fresh evidence from old data. Economic Modelling, 29(6), 2696–2703. https://doi.org/10.1016/j.econmod.2012.08.016

Eurostat (2017). Glossary: Carbon dioxide emissions. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_emissions.

Friedl, B., & Getzner, M. (2003). Determinants of CO2 emissions in a small open Environmental Science and Pollution Research economy, Ecological Economics 45, 133–148.

Friedrichs, J., & Inderwildi, O. R. (2013). The carbon curse: Are fuel rich countries doomed to high CO2 intensities? *Energy Policy, 62*, 1356–1365.

Fry, M. J. (1995). *Money, interest, and banking in economic development*. John Hopkins University Press, John Hopkins Studies in Development Series Baltimore and London.

Galeotti, M., A., Lanza, A., & Pauli, F. (2003). Reassessing the environmental kuznets curve for CO_2 emissions: A robustness exercise. *Ecological Economics 57*, 152-163.

Galeotti, M. (2003), Economic growth and the quality of the environment: Taking stock. (Fondazione Eni Enrico Mattei Working Paper No. 89).

Gao, L., & Zhang, L. (2014). Electricity consumption–economic growth – CO_2 emissions nexus in Sub-Saharan Africa: Evidence from panel cointegration. *African Development Review, 26*(2), 359 – 371.

Gill, A, R., Hassan, S., & Haseeb, M. (2019). Moderating role of financial development in environmental Kuznets: a case study of Malaysia. *Environmental Science and Pollution Research, 26*(22), 1 - 11. DOI: 10.1007/s11356-019-06565-1

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

Grossman G.M. and A.B. Krueger (1993). Environmental impacts of the North American Free Trade Agreement, in Peter Garber (Ed.), The U.S.-Mexico Free Trade Agreement. MIT Press, Cambridge.

Grossman, G.M., & Krueger, A. B. (1991). Environmental impact of a North American Free Trade Agreement. (NBER working paper No. 3914). National Bureau of Economic Research, http://doi: 10.3386/w3914

Habiba, U., & Xinbang, C. (2022). The impact of financial development on CO_2 emissions: new evidence from developed and emerging countries. Environmental Science Pollution Research International. doi: 10.1007/s11356-022-18533-3. Online ahead of print.

Halicioglu F. (2009). An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy*, 37(3), 1156 - 1164. http://doi: 10.1007/BF02773288

Hamdan, R., Ab-Rahim, R., & Fah, S. S. (2018). Financial Development and Environmental Degradation in ASEAN-5. *International Journal of Academic Research in Business and Social Sciences, 8*(12), 14 – 32. http://dx.doi.org/10.6007/IJARBSS/v8-i12/4987

Hasan, H., Oudat, M. S., Alsmadi, A. A., Nurfahasdi, M., & Ali, B. J. A. (2021). Investigating the causal relationship between financial development and carbon emission in the emerging country. *Journal of Governance & Regulation, 10*(2), 55–62. https://doi.org/10.22495/jgrv10i2art5.

Helpman E. (1998). Explaining the structure of foreign trade: where do we stand? *Review of World Economics*, *134*(4), 573-589.

Hogarth, J., Haywood, C., & Whitley, S. (2015). Low-carbon development in sub-saharan Africa: 20 cross-sector transitions; Overseas Development Institute: London, UK, 11–52.

Holtz-Eakin, D. & Selden, T. M. (1995). Stoking the fires? CO2 emissions and economic growth. *Journal of Public Economics, 57*, 85 - 101.

Huang W.M, G.W.M. Lee and C.C. Wu (2008), GHG emissions, GDP growth and the Kyoto protocol: a revisit of environmental kuznets curve hypothesis. *Energy Policy 36*, 239–47.

Hundie, S. K. (2018). Modelling energy consumption, carbon dioxide emissions and economic growth nexus in Ethiopia: evidence from cointegration and causality analysis. T*urkish Journal of Agriculture - Food Science and Technology*. https://doi.org/10.24925/turjaf.v6i6.699-709.1720 6 6 699

Hussen AM (2005) Principles of environmental economics and sustainability: an integrated and ecological approach, in: Bouvier, R. (Ed.), Air Pollution and Per Capita Income, Working Paper Series 84. Political Economy Research Institute (PERI) Routledge, New York.

Ibrahim, M. & Vo, X. V. (2021). Exploring the relationships among innovation, financial sector development and environmental pollution in selected industrialized countries. Journal of Environmental Management, 284(2021*), Journal of Environmental Management, 284* (2021), 112 – 127. https://doi.org/10.1016/j.jenvman.2021.112057

IEA (2020). Africa Energy Outlook, Executive Summary English Version; International Energy Agency: Paris, France, 1 – 4.

Im, K. S., Pesaran, M., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*(1), 53-74

IPCC (2014). Climate change 2014: Synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change [Core Writing Team, Pachauri, R. K. and Meyer, L. A. (eds.)]. IPCC, Geneva, Switzerland, 151.

Isiksal, A. Z., Samour, A., & Resatoglu, N. G. (2019). Testing the impact of real interest rate, income, and energy consumption on Turkey's CO2 emissions. *Environmental Science and Pollution Research, 26*(2019), 20219 – 20231. https://doi.org/10.1007/s11356-019-04987-5

Jalil, A., Feridun, M., (2011). The impact of growth, energy and financial development on the environment in China: A cointegration analysis. *Energy Economics, 33*(2), 284-291.

Jamel, L. & Maktouf, S. (2017). The nexus between economic growth, financial development, trade openness, and CO2 emissions in European countries. *Cogent Economics & Finance, 5*(1), 1 – 25. DOI: 10.1080/23322039.2017.1341456.

Jardón, A., Kuik, O., & Tol, R. S. J. (2017). Economic growth and carbon dioxide emissions: An analysis of Latin America and the Caribbean. *Atmósfera,* 30(2), 87 - 100. https://doi.org/10.20937/atm.2017.30.02.02.

Javid, M, & Sharif, F. (2016). Environmental kuznets curve and financial development in Pakistan*. Renewable and Sustainable Energy Reviews, 54(2016), 406 b-414.*

Jayanthakumaran, K., Verma, R., & Liu, Y. (2012). CO_2 emissions, energy consumption, trade and income: A comparative analysis of China and India. *Energy Policy* 42(C), 450-460. http://doi: 10.1016/j.enpol.2011.12.010

Jiang, C., & Ma, X. (2019). The impact of financial development on carbon emissions: A global perspective. *Sustainability, 11*(2019), 1–22; doi:10.3390/su11195241

Joe-Ming, L., Ku-Hsieh., C., & Chin-Ho, C. (2015). The relationship between CO_2 emissions and financial development: Evidence from OECD countries. *The Singapore Economic Review, 60*(5), 155 – 177. https://doi.org/10.1142/S0217590815501179

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

Jović, M., Laković, M., & Jovčevski, M. (2018). A carbon footprint from wood pellet. *Working and Living Environmental Protection, 15*(1), 81 - 88

Katircioglu, S., Gokmenoglu, K. K., & Eren, B. M. (2018). Testing the role of tourism development in ecological footprint quality: Evidence from top 10 tourist destinations. *Environmental Science and Pollution Research, 25*(33), 33611-33619.

Katircioglu, S., & Katircioglu, S. (2018). Testing the role of fiscal policy in the environmental degradation: The case of Turkey. *Environmental Science and Pollution Research, 25*(6), 5616-5630.

Ketenci, N. (2018). The environmental Kuznets curve in the case of Russia. *Russian Journal of Economics, 4*(3), 249 – 265. https://rujec.org/article/28482/

Khan, S., Khan, M.K., & Muhammad, B. (2021). Impact of financial development and energy consumption on environmental degradation in 184 countries using a dynamic panel model. *Environmental Science Pollution Research, 28*(8), 9542 – 9557.

Khuky, M. A. (2021). The financial development-environmental degradation nexus in Bangladesh: A long-run co-integration approach. *Energy Economics Letters, 8*(2), 109 - 121. doi: 10.18488/journal.82.2021.82.109.121

King, R., & Levine, R. (1993). Finance, entrepreneurship and growth. *Journal of Monetary Economics, 32*(3), 513-542.

Kivet, J. F. & Phillips, G. D. A. (1993). Alternative bias approximations in regressions with a lagged dependent variable. *Econometric Theory, 9*(2), 62 – 80.

Kriström, B., & Riera, P. (1996). Is the income elasticity of environmental improvements less than one? *Environmental and Resource Economics, 7*(1), 45 - 55.

Kuznets, S. (1955). Economic growth and income inequality. *The American economic review, 45*(2), 1 - 28. http://documents.worldbank.org/curated/en/2007/11/8838217/growth-co2-emissions- different-countries-fare.

Kwakwa, P. A., & Alhassan, H. (2018). The effect of energy and urbanization on carbon dioxide emissions: evidence from Ghana. *OPEC Energy Review, 42*(4), 300 – 330. https://doi.org/10.1111/opec.12133

Kwakwa, P. A., & Adu, G. (2016). Effects of income, energy consumption, and trade openness on carbon emissions in sub-Saharan Africa. *Journal of Energy Development, 41*(1/2) 86 -117. https://www.jstor.org/stable/90005933

Kwakwa, P. A., Alhassan, H., & Aboagye, S. (2018). Environmental Kuznets curve hypothesis in a financial development and natural resource extraction context: evidence from Tunisia. *Quantitative Finance and Economics, 2*(4), 981-1000. htpp://doi: 10.3934/QFE.2018.4.981

Le, T. H., Le, H. C., & Taghizadeh-Hesary, F. (2020). Does financial inclusion impact CO2 emissions? Evidence from Asia. *Finance Research Letters, 34* (2020), 101 - 151, 10.1016/j.frl.2020.101451

Lestari, I. D., Effendi, N., & Priyono, A. F. (2020). Financial development, economic growth, and environmental degradation nexus in ASIAN emerging markets. *Jurnal Ekonomi Pembangunan, 18* (2), 177-189. DOI: https://doi.org/10.29259/jep.v18i2.12565

Levin, A., Lin, C.E., & Chu, C.S.J. (2002). Unit root tests in panel data: Asymptotic and Finite sample properties. *Journal of Econometrics, 108* (1), 1 – 24.

Levine, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root test in panel data: Asymptotic and Finite Sample Properties. *Journal of Econometrics, 108*(1), 1-24. doi: https://doi.org/10.1016/S03044076(01)00098-7.

Levine, R., & Beck, M. (2004). *Finance and growth: Theory and Evidence*. NBER Working Paper No. 10766. Cambridge, MA: National Bureau of Economic Research.

Li, R., Lin, L., Jiang, L., Liu, Y., & Lee, C-C. (2021b). Does technology advancement reduce aggregate carbon dioxide emissions? Evidence from 66 countries with panel threshold regression model. *Environmental Science Pollution Research, 28*, 19710 –19725. https://doi.org/10.1007/s11356-020-11955-x

Li, P. & Ouyang, Y. (2019). The dynamic impacts of financial development and human capital on co_2 emission intensity in china: An ARDL approach. *Journal of Business Economics and Management, 20*(5), 939 – 957. https://doi.org/10.3846/jbem.2019.10509.

Longe, A. E., Bolaji, T. O., Soyemi, C. O., & Adebayo, E. O. (2020). dynamic links between financial development and carbon emission in Nigeria. *Izvestiya Journal of Varna University of Economics, 64* (2), p. 214 - 229.

Mabey, N., & McNally, R. (2019) foreign direct investment and the environment: from pollution havens to sustainable development. A world wildlife fund report. http://www.oecd.org/investment/mne/2089912.pdf

MacKay, D. (2008). Sustainable energy – without the hot air. http://www.dspace.cam.ac.uk/handle/1810/217849

Mahalik, M. K., & Mallick, H. (2014). Energy consumption, economic growth and financial development: exploring the empirical linkages for India. *Journal of Developing Areas, 48*(4), 139 - 159.

Mahmood, H., Alkhateeb, T. T. Y., & Furqan, M. (2020). Exports, imports, foreign direct investment and CO2 emissions in North Africa: Spatial analysis. *Energy Report, 6*(2020), 2403–2409.

Majeed, M. T., & Gillani, S. (2017). State capacity and health outcomes: An empirical Analysis. *Pakistan Journal of Commerce and Social Sciences, 11*(2), 671-697.

Majeed, M. M., & Mazhar, M. (2019). Financial development and ecological footprint: A global panel data analysis. *Pakistan Journal of Commerce and Social Sciences, 13*(2), 487-514.

Majeed, M. T. (2018). Information and communication technology (ICT) and environmental sustainability in developed and developing countries. *Pakistan Journal of Commerce and Social Sciences, 12*(3), 758-783

Malcolm, J. R. & Pitelka, L. (2000). Ecosystems & global climate change: A review of potential impacts on us terrestrial ecosystems and biodiversity. Arlington: Pew Center on Global Climate Change.

Mary M. (2015). What is environmental degradation? Retrieved from http://www.wisegeek.com/what-is-environmental-degradation.htm

Maurya, P.K., Ali, S.A., Ahmad, A., Zhou, Q., da Silva Castro, J., Khane, E., & Ali, H. (2020). An introduction to environmental degradation: Causes, consequence and mitigation. In: Environmental degradation: Causes and remediation strategies, Volume 1, Eds. Kumar, V., Singh, J. and Kumar, P., 1-20, https://doi.org/10.26832/aesa-2020-edcrs-01

Maverick, J.B. (2019). Market capitalization versus equity: What is the difference? Retrieved from https://www.investopedia.com/ask/answers/122314/what-difference-between-market-capitalization-and-equity-asp.

Mesagan, E. P., & Mike I. Nwachukwu, M. I. (2018). Determinants of environmental quality in Nigeria: Assessing the role of financial development. *Econometric Research in Finance, 3*(2), 56 – 78.

Mirza, F. M., & Kanwal, A. (2017). Energy consumption, carbon emissions and economic growth in Pakistan: Dynamic causality analysis. *Renewable and Sustainable Energy Reviews, 72*, 1233-1240.

Moghadam, H. E., & Lotfalipour, M. R. (2014). Impact of financial development on the environmental quality in Iran. *Chinese Business Review, 13*(9), 537-551 doi: 10.17265/1537-1506/2014.09.001.

Moomaw, W. R., & Unruh, G. C. (1997). Are environmental kuznets curves misleading us? The case of CO2 emissions. *Environment and Development Economics 2*, 451–463.

Musa, K. S., Chindo, S., & Maijama'a, R. (2021). Financial market development and Co_2 emissions nexus in Nigeria: An Application of ARDL Approach. *Journal of Developing Economies, 6*(1), 92-113. https://e-journal.unair.ac.id/JDE/index.

N'zue, F. F. (2006). Stock market development and economic growth: Evidence from Cote D'Ivoire. *African Development Review, 18*(1), 123 – 143.

Narayan, P. K., & Narayan, S. (2010). Carbon dioxide emissions and economic growth: Panel data evidence from developing countries. *Energy Policy, 38*(1), 661–666. https://doi.org/10.1016/j.enpol.2009.09.005

Nassani, A. A., Aldakhil, A. M., & Abro, M. M. Q. (2017). Environmental kuznets curve among BRICS countries: spot lightening finance, transport, energy and growth factors. *Journal of Clean Production, 154*(2), 474 – 487. doi: 10.1016/j.jclepro.2017.04.025

Nathaniel, S.P., & Iheonu, C.O. (2019). Carbon dioxide abatement in Africa: The role of renewable and non-renewable energy consumption. *Science Total Environment 2*, 679, 337–345.

Neumayer, E. (2002). Can natural factors explain any cross-country differences in carbon dioxide emissions? *Energy Policy, 30*, 7–12.

Neumayer, E. (2004). National carbon dioxide emissions: geography matters. *Area, 36*(1), 33-40.

Nwanyanwu, O.J. (2011). An analysis of bank's credit on the Nigerian economic growth (1992-2008). *Jos Journal of Economics, 4*(1), 43-58.

Nyarkoa, R., & Kaya, I. (2021). The impact of financial development on the environment – Focus on middle-income countries. Unpublished M.Sc thesis, Department of Management and Engineering, Linkoping University, Sweden).

Ogbeifun, L., & Shobande, O. A. (2021). A reevaluation of human capital accumulation and economic growth in OECD. J Public Aff. e02602.

Ogbeifun, L., & Shobande, O. A. (2020). Causality Analysis of Disaggregated FDI Inflows on Sectorial Growth in OECD Area. *Studia Universitatis Vasile Goldi? Arad, Seria? tiin?e Economice, 30*(4), 92–110.

Okikii, S.M., & Nzomoi, J.N. (2013). An analysis of the effects of stock market development on economic growth in Kenya. *International Journal of Economics and Finance, 5*(11), 145-151.

Olowofeso, E.O., Adeleke, A.O., & Udoji, A.O. (2015). Impact of private sector credit on economic growth in Nigeria. *CBN Journal of Applied Statistics, 6*(2), 81-101.

Olubusoye, O. E., & Dasuki, M. (2020). Carbon emissions and economic growth in Africa: are they related? *Cogent Economics and Finance, 8*(1), 1 - 21 https://doi.org/10.1080/23322039.2020.1850400

Omodero, C.O. (2020). Capital market determinants and market capitalization in Nigeria. *International Journal of Financial Research, 11*(1), 462-473.

Omri, A., Daly, S., Rault, C., & Chaibi, A, (2015). Financial development, environmental quality, trade and economic growth: What causes what in MENA countries. *Energy Economics, 48*(C), 242 - 252. DOI: 10.1016/j.eneco.2015.01.008.

Onafowora, O., & Owoye, O. (2014). Bounds testing approach to analysis of the environment Kuznets curve hypothesis. *Energy Economics, 44*(2), 47–62. doi: 10.1016/j.eneco.2014.03.025

Osabuohien, E.S., Efobi, U.R., & Gitau, C.M.W. (2014). Beyond the environmental Kuznets curve in Africa: Evidence from panel cointegration. *Journal of Environment and Policy Plan, 16*, 517–538.

Ouédraogo, M., Peng, D., Chen, X., Hashmi, S.H., & Sall, M.I. (2021). Dynamic effect of oil resources on environmental quality: Testing the environmental kuznets curve hypothesis for selected African countries. *Sustainability, 13*(2021), 3073 - 3649. https://doi.org/10.3390/su13073649.

Pal, D., & Mitra, S. K. (2017). The environmental kuznets curve for carbon dioxide in India and China: Growth and pollution at crossroad. *Journal of Policy Modeling, 39*(2), 371-385.

Panayotou T., (1995). Environmental degradation at different stages of economic development. In I. Ahmed and J. A. Doeleman (Eds.), Beyond Rio: The Environmental Crisis and Sustainable Livelihoods in the Third World (pp. 13-36). London: International Labour Organization and Macmillan Press Ltd.

Panayotou, T. (1997). Demystifying the environmental kuznets curve: Turning a Black Box into a Policy Tool. *Environment and Development Economics, 2,* 465 – 484.

Panayotou, T. (2003). Economic growth and the environment. Paper prepared for and presented at the Spring seminar of the United Nations Economic Commission for Europe, Geneva, and Economic Survey of Europe.

Pauli, F. (2003). Environmental kuznets curve investigation using a varying coefficient AR model. Ecological and Environmental Economics (EEE), Working Papers Series N. 12.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics, 61*(3), 653 - 670. doi:https://doi.org/10.1111/1468-0084.0610s1653.

Pedroni. P. (2001) Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory, 20*, 597-625.

Pesaran M. H. (2004). General diagnostic tests for cross section dependence in panels. University of Cambridge, Faculty of Economics, Cambridge Working Papers in Economics No. 0435.

Pesaran M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica, 74*(4), 967–1012. doi: https://doi.org/10.1111/j.1468-0262.2006.00692.x.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289-326.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association, 94*(446), 621-634.

Phillips, P.C.B., & Hansen, B. E. (1990) statistical inference in instrumental variables regression with I (1) Processes. *Review of Economic Studies 57*, 99–125.

Piaggio, M., & Padilla, E. (2012). CO2 emissions and economic activity: heterogeneity across countries and non-stationary Series. *Energy Policy, 46*, 370 - 381.

Piñeiro - Chousa, J., Tamazian, A., & Vadlamannati, K. C. (2017). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. *Energy Policy, 37*(1), 1 – 19, Available at SSRN: https://ssrn.com/abstract=2894442.

Piñeiro Chousa, J., Tamazian, A., & Vadlamannati, K.C. (2017). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy, 37*(1), 200 – 219.

Raphael, T.M. (2012). The relationship between trading volume and stock returns in the JSE securities exchange in South Africa. *Corporate Ownership and Control, 9*(4), 199-207.

Raymond, L. (2004). Economic growth as environmental policy? Reconsidering the environmental kuznets curve. *Journal of Public Policy, 24*(3), 327-348.

Roberts, G., Barbier, E., & Van't Veld, K. (2019). Global emissions from crude oil: The effect of oil-deposit heterogeneity. *Energy Policy, 132*, 654–664.

Rosa, E. A., & Dietz, T. (2003). Footprints on the earth: The environmental consequences of modernity. *American Sociological Review, 68*(2), 279 – 300. DOI: 10.2307/1519769

Runge C. F. (1994). *Freer trade, protected environment: balancing trade liberalization with environmental interests,* Council on Foreign Relations Books.

Saboori, B., Sulaiman, J., & Mohd, S. (2012). Economic growth and CO2 emissions in Malaysia: A cointegration analysis of the environmental kuznets curve. *Energy Policy, 51*(December), 184–191. https://doi.org/10.1016/j.enpol.2012.08.065

Sadorsky, P. (2011). The impact of financial development on energy consumption in emerging economies. *Energy Policy, 38*(5), 2528 – 2535.

Sarkodie, S. A. (2018). The invisible hand and EKC hypothesis: What are the drivers of environmental degradation and pollution in Africa? *Environmental Science and Pollution Research, 25*(22), 21993–22022. https://doi.org/10.1007/s11356-018-2347-x.

Sarkodie, S. A., & Strezov, V. (2019). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. *Science of the Total Environment, 646*, 862-871. Available at: https://doi.org/10.1016/j.scitotenv.2018.07.365.

Schmalensee R., Stoker, T. M., & Judson, R. A, (1998). World carbon dioxide emissions: 1950-2050. *The Review of Economics and Statistics, 80*(1), 15-27.

Schmidheiny, S., & Zorraquin, F. J. (1998). Financing change: The financial community, eco-efficiency, and sustainable development. MIT Press, USA.

Sehrawat, M., Giri, A. K., & Mohapatra, G. (2015). The impact of financial development, economic growth and energy consumption on environmental degradation: Evidence from India. *Management of Environmental Quality, 26*(5), 666–682. https://doi.org/10.1108/MEQ-05-2014-0063

Seldon T. M., & Song, D. (1994). Environmental quality and development: Is there a kuznets curve for air pollution emissions? *Journal of Environmental Economics And Management 27*, 147-162.

Sengupta, R. (1996). Economic development and CO2-emission: economy-environment relation and policy approach for the choice of emission standard. Institute for Economic Development, Boston University.

Shafik N., & Bandyopadhyay S., (1994). Economic growth and environmental quality: Time series and cross-country evidence. (Policy research working paper 904). World Development Report. The World Bank

Shahbaz, M., Lean, H. H., & Shabbir, M. S. (2012). Environmental kuznets curve hypothesis in Pakistan: cointegration and Granger causality. *Renewable Sustainable Energy Review, 16*(5), 2947 - 2953. https://doi: 10.1016/j.rser.2012.02.015.

Shahbaz, M., & Nasir, M., & Roubaud, D. (2018). Environmental degradation in France: The effects of FDI, financial development, and energy innovations. *Energy Economics, 74*(2), 843-857. DOI: https://doi.org/10.1016/j.eneco.2018.07.020 Available at: https://www.climatewatchdata.org/ghg-emissions.

Shahbaz, M., Aviral, K. T., & Nasir, M. (2013). The effects of financial development, economic growth, coal consumption and trade openness on CO_2 Emissions in South Africa. *Energy Policy*, *61*, 1452 – 1459. doi: https://doi.org/10.1016/j.enpol.2013.07.006.

Shahbaz, M., Destek, M. A., Dong, K., & Jiao, Z. (2021). Time-varying impact of financial development on carbon emissions in G-7 countries: Evidence from the long history. *Technological Forecasting and Social Change, 171*(C). DOI: 10.1016/j.techfore.2021.120966.

Shahbaz, M., Haouas, I., Sohag, & Ozturk, I. (2020). The financial development-environmental degradation nexus in the United Arab Emirates: the importance of growth, globalization and structural breaks. *Environmental Science Pollution Research International, 27*(10),10685-10699. doi: 10.1007/s11356-019-07085-8.

Shahbaz, M., Khan, S., & Tahir, M.I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: fresh evidence from multivariate framework analysis. *Energy Economics, 40*(C) 8 - 21.

Shahbaz, M., Shahzad S. J. H., Ahmad, N., & Alam, S. (2016). Financial development and environment quality: The way forward. *Energy Policy 98*(2), 353 - 364.

Shahbaz, M., Solarin, S. A., & Mahmood, H. (2012). Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis. Munich Personal Repec Archive (MPRA), Paper No. 40603.

Shobande, O. A., & Ogbeifun, L. (2021). The criticality of financial development and energy consumption for environmental sustainability in OECD countries: Evidence from dynamic panel analysis. *International Journal of Sustainable Development & World Ecology*,

Siha, A., Shahbaz, M., & Balsalobre – Lorente (2017). Exploring the relationship between energy usage segregation and environmental degradation in N-11 countries. *Journal of Cleaner Production, 168*(1), 1217-1229. DOI: 10.1016/j.jclepro.2017.09.071

Sinha, A., & Sen, S. (2016). Atmospheric consequences of trade and human development: A case of BRIC countries. *Atmospheric Pollution Research, 7*, 65-87.

Solarin, S. A., Al-Mulali, U., Gan, G. G. G., & Shahbaz, M. (2018). The impact of biomass energy consumption on pollution: Evidence from 80 developed and developing countries. *Environmental Science and Pollution Research, 25*(23), 22641-22657.

Stern, D. I. (1998). Progress on the environmental Kuznets curve? *Environment and Development Economics, 3*(2), 173-196.

Stern, D. I. (2003). The rise and fall of the environmental kuznets curve. *World Development, 32*(8), 1419 - 1439.

Stern, N., Peters, S., Bakhshi, V., Bowen, A., Cameron, C., Catovsky, S., & Garbett, S. L. (2006). Economics, ethics and climate change. Stern review: *The Economics of Climate Change, 7*(1), 23-40.

Stokey, N. L. (1998). Are there limits to growth? *International Economic Review, 39*(1), 1-31.

Tahir, T., Luni, T., Majeed, M.T., & Zafar A. (2021). The impact of financial development and globalization on environmental quality: evidence from South Asian economies. *Environental Science Pollution Research, 28*(7), 8088–8101.

Talukdar, D., & Meisner, C. M. (2001). Does the private sector help or hurt the environment? Evidence from carbon dioxide pollution in developing countries. *World Development*, *29*, 827–840.

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy, 37*(1), 246-253.

Tamazian. A., & Rao. B. B. (2010). Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. *Energy Economics*, *32*, 137–145.

The IPCC's Fifth Assessment Report (2021). What's in it for Africa? - World | ReliefWeb. (n.d.). Retrieved May 7, 2022, from https://reliefweb.int/report/world/ipcc-s-fifth-assessment-report-whats-it-africa.

The White House (2016). Executive order on tackling the climate crisis at home and abroad. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/.

Tian, Q., Zhou, Z. Q., Jiang, S. R., Ren, L. P., & Qiu, J. (2004). Research progress in butachlor degradation in the environment. *Pesticides-Shenyang, 43*(5), 205-208.

Tiba, S.; Frikha, M. (2019). The controversy of the resource curse and the environment in the SDGs background: The African context. *Resources Policy, 62*, 437–452.

Tiwari, A.K., Shahbaz, M., & Adnan-Hye, Q.M. (2013). The environmental kuznets curve and the role of coal consumption in India: Cointegration and causality analysis in an open economy. *Renewable and Sustainable Energy Reviews*, (18), 519-527. https://doi.org/10.1016/j.rser.2012.10.031

Todaro, M.P. (1985). *Economic development in the Third World*, Third edition, Longman Group Ltd, England.

Trimurthyvishal (2010). Environmental degradation. Retrieved from http://www.studymode.com/essays/Environmental-Degradation- 507423.html.

Twerefou., D. K., Danso-Mensah, K., & Bokpin, G. A. (2017). The environmental effects of economic growth and globalization in Sub-Saharan Africa: A panel general method of moments approach. *Research in International Business and Finance, 42*(C), 939-949 DOI: 10.1016/j.ribaf.2017.07.028

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

UNCTAD (United Nations Conference on Trade and Development), (2012). Economic development in Africa: structural transformation and sustainable development in Africa. UNCTAD, New York.

UNECA. (2012). A green economy in the context of sustainable development and poverty eradication: What are the implications for Africa? RIO+20 United Nations Conference on Sustainable Development; United Nations Economic Commission for Africa: Addis Ababa, Ethiopia, 1 – 27.

United Nations Department of Economic and Social Affairs Population Division. (2019). World population prospects 2019. In Department of Economic and Social Affairs. World Population Prospects.

Wang, Q., Zeng, Y. E., & Wu, B. W. (2016). Exploring the relationship between urbanization, energy consumption, and CO2 emissions in different provinces of China. *Renewable and Sustainable Energy Reviews, 54*, 1563-1579.

World Bank (2012). Africa's plus: An analysis of issues shaping africa's economic future; Economist for the Africa Region; World Bank: Washington, DC, USA.

World Bank (2014). Africa's plus: An analysis of issues shaping africa's economic future; Economist for the Africa Region; World Bank: Washington, DC, USA.

World Bank, (2008). *World development indicators*, 2008. Washington, DC: World Bank.

World Bank, (2009). *World development indicators*, 2009 CD-ROM.

World Bank. (2016) Global financial development report 2016: Financial development. World Bank, Washington, DC. www.worldbank.org/en/publication/gfdr

World Bank. (2021) World development indicators. Available online: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?view=chart&locations=ZG.

World Bank. (2021b). World development indicators. Retrieved from World Bank: http://data.worldbank.org/indicator

World Bank. Annual Report (2018). Ending poverty, Investing in opportunity; World Bank: Washington, DC, USA, 2018; pp. 10–65.

World Development Indicators (2021). The World Bank. Available at: https://databank.worldbank.org/source/world-development-indicators

World Development Indicators (2022). Available from: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators.

Xu, L. (2013). On the evaluation of performance system incorporating "green credit" policies in china's financial industry. *Journal of Financial Risk Management 2*(2), 33 - 37. DOI: 10.4236/jfrm.2013.22005

Yusuf, A. M., Abubakar, A. B., & Mamman, S. O. (2020). Relationship between greenhouse gas emission, energy consumption, and economic growth: Evidence from some selected oil-producing African countries. *Environmental Science Pollution Research, 27*(13), 15815-15823. doi: 10.1007/s11356-020-08065-z.

Zaidi, S. A. H., Zafar, M. W., Shahbaz, M., & Hou F. (2019). Dynamic linkages between globalization, financial development and carbon emissions: evidence from Asia Pacific Economic Cooperation countries. *Journal of Clean Production, 228*, 533–543.

Zakaria, M., & Bibi, S. (2019). Financial development and environment in South Asia: The role of institutional quality. *Environmental Science and Pollution Research, 26*(8), 7926-7937.

Zarsky, L. (1999). Havens, halos and spaghetti: Untangling the evidence about foreign direct investment and the environment. *Foreign direct Investment and the Environment, 13*(8), 47-74.

Zhang, Y. J. (2011). The impact of financial development on carbon emissions: An empirical analysis in China. *Energy Policy, 39*(4), 2197 - 2203.

Zhang, Y., & Zhang, S. (2018). The impacts of GDP, trade structure, exchange rate and FDI inflows on China's carbon emissions. *Energy Policy, 120*(2), 347-353.

Ziaei, S. M. (2015). Effects of financial development indicators on energy consumption and CO2 emission of European, East Asian and Oceania countries. *Renewable Sustainable Energy Review, 42*, 752–759.

Ziaei, S. M. (2018). US interest rate spread and energy consumption by sector (evidence of pre and post implementation of the Fed's LSAPs policy). *Energy Reports, 4*(2018), 288 – 302.

APPENDICES

Data

Country	Year	CO2	EFPI	EFPC	CPS	LLR	MKT	SMT
Côte d'Ivoire	1990	4781520	0.61	0.69	36.50	28.76	0.05	2.17
Côte d'Ivoire	1991	4308864	0.63	0.68	36.01	28.59	0.05	2.22
Côte d'Ivoire	1992	3843536	0.60	0.71	32.06	28.33	0.05	2.26
Côte d'Ivoire	1993	5092960	0.58	0.69	28.66	26.38	0.03	2.18
Côte d'Ivoire	1994	4132991	0.56	0.69	18.52	26.23	0.08	1.83
Côte d'Ivoire	1995	6115469	0.56	0.75	18.50	26.04	0.04	1.18
Côte d'Ivoire	1996	7335328	0.55	0.77	11.24	16.07	0.08	1.52
Côte d'Ivoire	1997	7012656	0.57	0.83	11.10	15.26	0.09	1.08
Côte d'Ivoire	1998	6584208	0.58	0.87	10.25	14.73	0.10	1.04
Côte d'Ivoire	1999	5939512	0.60	0.90	9.47	14.42	0.40	5.83
Côte d'Ivoire	2000	6463296	0.61	0.98	9.76	13.98	0.20	7.56
Côte d'Ivoire	2001	7397616	0.59	0.95	9.44	13.98	0.05	0.87
Côte d'Ivoire	2002	6957936	0.59	0.91	9.64	17.84	0.10	1.33
Côte d'Ivoire	2003	5133073	0.57	0.90	9.03	13.11	0.11	1.47
Côte d'Ivoire	2004	7335328	0.55	0.84	9.48	14.02	0.21	2.41
Côte d'Ivoire	2005	7496544	0.55	0.82	8.85	13.69	0.15	1.50
Côte d'Ivoire	2006	6811376	0.54	0.77	10.15	14.86	0.42	2.58
Côte d'Ivoire	2007	6536576	0.50	0.74	12.16	18.85	0.57	1.98
Côte d'Ivoire	2008	6591536	0.50	0.81	12.03	18.44	0.86	4.12
Côte d'Ivoire	2009	5514320	0.48	0.77	12.70	21.31	0.71	3.93
Côte d'Ivoire	2010	6063920	0.49	0.79	13.09	23.40	0.65	3.17
Côte d'Ivoire	2011	6342384	0.48	0.85	13.17	25.97	0.32	1.85
Côte d'Ivoire	2012	8540010	0.51	0.80	13.68	25.40	0.48	2.45
Côte d'Ivoire	2013	9679770	0.47	0.78	14.32	24.82	0.86	3.11
Côte d'Ivoire	2014	9903224	0.52	0.77	14.69	24.82	0.82	3.41
Côte d'Ivoire	2015	9554741	0.57	0.76	16.74	26.11	1.14	4.18
Côte d'Ivoire	2016	11982756	0.55	0.76	17.67	27.37	1.19	3.27
Côte d'Ivoire	2017	12001913	0.59	0.79	19.25	28.12	1.03	2.62
Côte d'Ivoire	2018	10352442	0.60	0.76	19.27	29.91	0.34	2.07
Côte d'Ivoire	2019	10535084	0.61	0.74	19.20	30.69	0.26	1.86
Côte d'Ivoire	2020	10963848	0.63	0.73	20.59	35.98	0.28	2.31
Côte d'Ivoire	2021	11706642	0.63	0.73	21.28	38.89	0.37	2.31
Côte d'Ivoire	2022	12635477	0.63	0.73	21.28	38.89	0.37	2.31
Ghana	1990	3790882	0.56	0.68	4.93	14.14	0.04	2.88
Ghana	1991	4209288	0.96	0.71	3.66	15.56	0.03	2.97
Ghana	1992	3661745	0.89	0.71	4.94	20.53	0.05	3.16
Ghana	1993	4309505	0.98	0.74	4.84	19.84	0.07	3.36

Ghana	1994	5088912	0.89	0.75	5.25	22.51	1.27	3.63
Ghana	1995	5153605	0.94	0.77	5.07	21.64	0.29	1.13
Ghana	1996	5468649	0.93	0.74	6.01	20.60	0.23	0.97
Ghana	1997	6204804	0.84	0.69	8.20	23.84	0.60	3.66
Ghana	1998	6244973	0.82	0.68	9.36	22.86	0.77	4.13
Ghana	1999	6370451	0.84	0.74	12.56	24.09	0.26	2.16
Ghana	2000	6101182	0.80	0.70	13.97	28.17	0.14	1.39
Ghana	2001	6733777	0.83	0.69	11.88	31.45	0.24	4.46
Ghana	2002	7232698	0.89	0.71	12.15	34.11	0.16	2.86
Ghana	2003	7438500	0.88	0.72	12.49	31.05	0.58	6.87
Ghana	2004	7153326	0.85	0.73	13.17	32.72	0.82	15.18
Ghana	2005	6802875	0.88	0.76	15.54	32.11	0.47	8.36
Ghana	2006	9159489	0.89	0.73	10.86	22.77	0.25	6.79
Ghana	2007	9618768	0.87	0.78	14.49	25.72	0.59	6.06
Ghana	2008	8925351	0.93	0.78	12.61	27.46	1.00	10.08
Ghana	2009	7497608	1.05	0.85	17.74	28.25	0.20	2.13
Ghana	2010	9709648	1.10	0.84	16.66	29.62	0.32	3.45
Ghana	2011	11226017	1.10	0.93	17.20	30.55	0.65	8.20
Ghana	2012	14382069	1.17	1.01	18.07	30.36	0.12	3.52
Ghana	2013	14339920	1.19	1.02	15.29	21.95	0.31	2.36
Ghana	2014	14975182	1.26	1.02	16.50	23.64	0.32	2.11
Ghana	2015	16026217	1.27	1.04	17.93	25.67	0.26	1.85
Ghana	2016	15562399	1.29	1.04	17.44	26.28	0.20	1.04
Ghana	2017	13943429	1.37	1.05	16.10	25.49	0.22	0.89
Ghana	2018	17104952	1.47	1.05	13.71	25.13	0.16	0.77
Ghana	2019	18706476	1.46	1.01	13.94	26.39	0.11	0.46
Ghana	2020	19654350	1.55	1.04	13.06	30.82	0.05	0.35
Ghana	2021	21312802	1.55	1.04	13.13	31.91	0.05	0.54
Ghana	2021	23024352	1.55	1.04	13.13	31.91	0.05	0.54
Kenya	1990	5687209	0.66	0.72	18.66	29.58	0.16	1.94
Kenya	1991	4708958	0.69	0.69	19.96	30.98	0.18	2.04
Kenya	1992	5402381	0.64	0.72	22.15	36.52	0.21	1.18
Kenya	1993	6214680	0.66	0.68	18.50	37.07	0.21	1.14
Kenya	1994	6421892	0.62	0.67	19.83	38.02	0.96	2.25
Kenya	1995	7405763	0.62	0.67	25.81	42.23	0.66	2.97
Kenya	1996	9154939	0.65	0.58	21.68	35.79	0.59	3.96
Kenya	1997	8119526	0.63	0.54	24.36	38.42	0.74	5.38
Kenya	1998	9896093	0.68	0.57	23.96	35.81	0.53	3.55
Kenya	1999	10028879	0.64	0.59	26.57	35.77	0.38	3.25
Kenya	2000	10390516	0.59	0.55	25.76	35.16	0.30	3.01
Kenya	2001	9236819	0.62	0.56	25.22	35.24	0.30	3.76

Kenya	2002	7819235	0.63	0.60	25.85	38.16	0.28	2.61
Kenya	2003	6587069	0.62	0.59	25.16	39.02	1.34	4.78
Kenya	2004	7438961	0.59	0.57	27.29	39.33	1.76	7.29
Kenya	2005	8338351	0.69	0.58	26.28	38.91	2.69	7.90
Kenya	2006	9335661	0.70	0.61	22.89	34.60	5.28	11.99
Kenya	2007	9540667	0.66	0.64	23.04	36.06	3.53	8.45
Kenya	2008	9911045	0.63	0.54	25.38	36.11	2.07	6.84
Kenya	2009	11966561	0.63	0.52	21.87	31.87	0.47	1.81
Kenya	2010	11744717	0.68	0.60	23.99	35.51	1.75	5.49
Kenya	2011	12928337	0.56	0.57	27.37	36.57	1.96	8.99
Kenya	2012	11967255	0.63	0.62	26.40	36.53	1.79	4.36
Kenya	2013	12905685	0.63	0.62	28.33	37.79	2.93	3.55
Kenya	2014	13881515	0.60	0.62	34.52	42.30	1.48	3.12
Kenya	2015	16295494	0.63	0.68	36.70	42.82	0.97	3.08
Kenya	2016	17390574	0.57	0.59	35.57	40.33	1.09	2.78
Kenya	2017	17018376	0.51	0.61	33.15	39.35	0.98	2.22
Kenya	2018	18169172	0.58	0.64	31.20	39.36	0.55	2.09
Kenya	2019	19177196	0.57	0.62	30.83	38.07	0.47	1.88
Kenya	2020	18275836	0.66	0.69	32.15	41.20	0.48	2.26
Kenya	2021	19875402	0.66	0.69	31.12	38.99	0.41	2.87
Kenya	2022	21186036	0.66	0.69	31.12	38.99	0.41	2.87
Mauritius	1990	1461936	15.53	1.19	33.06	63.04	1.04	3.87
Mauritius	1991	1520560	16.03	1.21	34.24	67.68	0.96	4.82
Mauritius	1992	1707424	16.08	1.24	37.72	69.84	1.08	5.06
Mauritius	1993	1773376	15.57	1.22	42.02	71.18	1.15	5.36
Mauritius	1994	1623152	13.88	1.07	45.38	72.00	2.35	6.31
Mauritius	1995	1828336	14.77	1.14	47.02	77.68	1.33	4.00
Mauritius	1996	1949248	14.35	1.16	43.40	73.94	2.24	6.68
Mauritius	1997	1996880	15.73	1.23	49.10	77.47	2.92	8.01
Mauritius	1998	2169088	15.55	1.18	56.41	75.93	2.27	5.55
Mauritius	1999	2425568	10.53	0.84	56.44	79.95	1.63	4.65
Mauritius	2000	2689376	13.51	1.08	56.50	78.05	1.40	5.26
Mauritius	2001	2861584	14.97	1.21	56.85	79.01	2.28	10.77
Mauritius	2002	2883568	12.63	1.02	57.70	82.45	1.14	4.62
Mauritius	2003	3059440	13.44	1.08	70.64	92.16	1.76	5.42
Mauritius	2004	3088752	13.21	1.12	70.91	98.26	1.73	5.38
Mauritius	2005	3293936	12.72	1.07	72.90	98.98	2.15	6.01
Mauritius	2006	3627360	12.09	1.02	68.69	93.11	2.23	3.16
Mauritius	2007	3685984	10.60	0.92	71.75	93.77	5.05	5.20
Mauritius	2008	3766592	10.89	1.01	81.80	96.50	3.49	7.48
Mauritius	2009	3707968	11.33	1.07	80.08	96.25	3.73	5.17

Mauritius	2010	3913152	10.44	1.03	85.36	97.49	3.65	4.71
Mauritius	2011	3916816	9.88	1.04	89.31	96.64	4.43	6.50
Mauritius	2012	3964448	9.53	1.01	98.85	98.57	2.54	4.12
Mauritius	2013	4067040	8.92	0.98	104.89	96.87	2.65	3.59
Mauritius	2014	4206272	9.27	1.09	96.73	99.30	3.62	5.29
Mauritius	2015	4209936	9.13	1.03	100.02	104.05	3.94	6.37
Mauritius	2016	4345504	8.53	1.01	93.50	106.74	2.61	4.22
Mauritius	2017	4536032	8.21	1.03	98.98	110.41	3.39	4.61
Mauritius	2018	4514048	6.96	0.88	75.31	110.97	3.21	4.62
Mauritius	2019	4521376	7.39	1.00	78.08	117.55	2.66	4.33
Mauritius	2020	4208353	5.75	0.83	91.87	156.84	2.84	5.05
Mauritius	2021	4471674	5.75	0.83	86.50	160.06	2.91	4.19
Mauritius	2022	4593306	5.75	0.83	86.50	160.06	2.91	4.19
Namibia	1990	984774	0.14	0.33	22.28	20.47	0.18	3.11
Namibia	1991	1055232	0.15	0.35	22.36	23.26	0.21	2.94
Namibia	1992	1150496	0.11	0.25	15.90	28.85	0.21	2.93
Namibia	1993	1388656	0.12	0.30	20.66	31.71	0.27	4.54
Namibia	1994	1571856	0.13	0.23	24.50	33.88	0.33	6.21
Namibia	1995	1619488	0.11	0.21	28.86	37.47	0.08	1.58
Namibia	1996	1722080	0.11	0.23	29.36	39.12	0.95	7.96
Namibia	1997	1769712	0.13	0.27	29.99	37.88	0.56	3.35
Namibia	1998	1817344	0.12	0.27	29.13	37.44	0.34	3.04
Namibia	1999	1663456	0.11	0.21	31.39	40.54	0.58	3.36
Namibia	2000	1604832	0.13	0.28	32.09	39.84	0.47	6.11
Namibia	2001	2011535.9	0.13	0.31	35.71	37.60	0.15	3.46
Namibia	2002	1788032	0.13	0.24	32.74	37.63	0.05	1.95
Namibia	2003	1883296	0.13	0.26	30.80	36.39	0.06	3.97
Namibia	2004	1971232	0.14	0.30	34.70	38.92	0.30	21.55
Namibia	2005	2311984	0.15	0.33	48.09	37.78	0.08	4.55
Namibia	2006	2337632	0.16	0.36	51.77	41.83	0.22	10.96
Namibia	2007	2264352	0.15	0.35	51.63	42.18	0.23	11.80
Namibia	2008	2704032	0.14	0.36	48.43	41.96	0.17	30.10
Namibia	2009	2762656	0.14	0.28	63.32	62.43	0.28	80.38
Namibia	2010	2839600	0.14	0.30	61.25	62.73	0.18	17.54
Namibia	2011	2782096	0.13	0.31	61.83	64.22	0.10	11.23
Namibia	2012	3355055	0.15	0.26	61.29	57.21	0.46	12.47
Namibia	2013	2567728	0.13	0.36	60.53	58.73	0.28	10.37
Namibia	2014	3677997	0.13	0.18	66.66	55.15	0.56	8.35
Namibia	2015	3851304	0.14	0.27	65.63	55.57	0.56	10.36
Namibia	2016	4051196	0.13	0.25	68.57	54.56	0.59	7.26
Namibia	2017	4216153	0.14	0.27	65.09	57.16	0.64	4.44
Namibia	2018	4154920	0.14	0.30	65.84	57.63	0.70	4.87

Namibia	2019	4107047	0.12	0.43	70.95	63.65	0.78	3.76
Namibia	2020	3945144	0.14	0.19	72.77	71.54	0.35	1.95
Namibia	2021	4014822	0.14	0.19	68.61	72.35	0.45	2.77
Namibia	2021	4142055	0.14	0.19	68.61	72.35	0.45	2.77
Nigeria	1990	38857280	0.65	0.63	4.96	11.64	0.07	1.27
Nigeria	1991	41929196	0.72	0.62	5.24	13.40	0.09	1.94
Nigeria	1992	46265316	0.76	0.65	8.23	14.25	0.11	1.18
Nigeria	1993	44814164	0.80	0.66	7.01	15.79	0.11	1.41
Nigeria	1994	34934724	0.78	0.62	8.04	15.09	0.13	1.50
Nigeria	1995	33416744	0.75	0.65	6.51	10.28	0.19	1.07
Nigeria	1996	36788590	0.72	0.65	6.17	9.06	0.62	2.47
Nigeria	1997	41008772	0.73	0.65	7.03	9.73	0.92	3.97
Nigeria	1998	37745960	0.74	0.63	7.62	10.94	1.12	5.91
Nigeria	1999	39586896	0.73	0.66	8.17	12.76	0.19	3.83
Nigeria	2000	78823110	0.71	0.66	8.25	14.67	0.20	5.26
Nigeria	2001	86718730	0.73	0.65	9.88	15.90	0.23	6.26
Nigeria	2002	94303640	0.73	0.66	8.08	13.53	0.74	6.84
Nigeria	2003	100008040	0.74	0.68	8.91	13.03	1.08	8.69
Nigeria	2004	98685310	0.76	0.67	8.46	11.76	1.23	10.59
Nigeria	2005	105757816	0.78	0.69	8.44	11.30	1.11	8.78
Nigeria	2006	97808930	0.81	0.72	8.12	11.73	1.52	10.96
Nigeria	2007	94269810	0.71	0.67	13.80	19.29	6.30	20.45
Nigeria	2008	94772180	0.74	0.68	18.63	23.81	4.92	34.79
Nigeria	2009	74885064	0.69	0.68	19.63	25.14	1.52	13.94
Nigeria	2010	112314216	0.76	0.71	13.49	21.36	1.41	10.10
Nigeria	2011	129568744	0.67	0.60	11.04	22.48	0.96	9.92
Nigeria	2012	109065930	0.71	0.68	10.60	24.93	0.90	7.28
Nigeria	2013	116360424	0.68	0.61	11.53	25.45	1.22	7.73
Nigeria	2014	122995920	0.78	0.60	13.30	22.69	0.94	8.18
Nigeria	2015	109231810	0.79	0.60	13.08	22.37	0.84	8.17
Nigeria	2016	116950170	0.83	0.62	14.61	27.38	0.37	5.07
Nigeria	2017	112776760	0.81	0.60	12.85	24.78	0.59	5.93
Nigeria	2018	105230430	0.80	0.58	10.25	25.36	0.65	8.20
Nigeria	2019	127304180	0.81	0.58	11.16	23.93	0.61	6.19
Nigeria	2020	130176776	0.81	0.57	12.13	25.22	0.57	4.39
Nigeria	2021	136986780	0.81	0.57	13.45	25.24	0.71	7.02
Nigeria	2022	142118051	0.81	0.57	13.45	25.24	0.71	7.02
South Africa	1990	312930240	0.83	0.70	71.94	47.81	6.54	6.02
South Africa	1991	326026700	0.87	0.74	86.10	48.91	5.98	4.37
South Africa	1992	301325400	0.53	0.42	90.98	44.82	4.93	4.42
South Africa	1993	320345300	0.66	0.74	95.83	41.52	5.38	3.65

South Africa	1994	338573400	0.80	0.79	101.06	43.34	8.70	5.15
South Africa	1995	361578340	0.64	0.61	105.01	44.01	9.29	5.75
South Africa	1996	363609380	0.81	0.83	105.54	44.64	16.32	11.03
South Africa	1997	385016900	0.81	0.75	102.37	47.40	24.90	18.29
South Africa	1998	377016480	0.76	0.74	103.72	49.60	35.48	32.21
South Africa	1999	374686880	0.74	0.78	118.17	50.26	48.06	28.04
South Africa	2000	378055420	0.83	0.86	117.10	47.36	46.46	34.51
South Africa	2001	371370000	0.73	0.82	121.07	51.42	26.11	23.98
South Africa	2002	356304770	0.78	0.88	97.32	52.12	36.94	26.20
South Africa	2003	404116500	0.72	0.79	102.77	53.93	24.90	18.81
South Africa	2004	449024130	0.69	0.80	112.82	55.04	32.75	18.93
South Africa	2005	415930600	0.76	0.91	122.28	59.76	38.53	20.26
South Africa	2006	446555200	0.68	0.92	139.01	65.42	57.18	24.43
South Africa	2007	464886800	0.64	0.81	142.42	71.09	77.38	31.12
South Africa	2008	494999700	0.70	1.00	125.96	73.30	64.10	41.98
South Africa	2009	480403100	0.69	1.04	121.09	69.71	65.96	27.22
South Africa	2010	462806940	0.65	0.96	124.09	68.17	66.42	29.97
South Africa	2011	465774750	0.64	0.95	118.97	67.83	49.29	28.62
South Africa	2012	458954200	0.68	0.99	125.17	66.55	52.22	24.99
South Africa	2013	458628200	0.69	0.89	127.03	64.98	57.93	24.63
South Africa	2014	471866000	0.69	1.00	128.84	65.24	64.45	26.31
South Africa	2015	446221020	0.59	0.80	127.20	67.30	67.49	31.79
South Africa	2016	456972860	0.54	0.83	124.36	66.31	124.37	42.30
South Africa	2017	439380130	0.70	1.05	127.03	66.14	107.41	33.28
South Africa	2018	435237200	0.67	0.97	118.70	66.32	72.87	34.09
South Africa	2019	466924160	0.63	0.86	117.43	67.05	73.42	26.96
South Africa	2020	435831840	0.70	1.04	109.17	74.12	87.60	27.94
South Africa	2021	435928900	0.70	1.04	93.42	70.31	83.26	28.46
South Africa	2022	440377200	0.70	1.04	93.42	70.31	83.26	28.46

Country	GDPPC	ENC	URB	FDI	SER
Côte d'Ivoire	1909.83	165.10	39.35	0.45	1.28
Côte d'Ivoire	1839.75	125.10	39.72	0.18	1.29
Côte d'Ivoire	1768.20	106.40	40.09	0.62	1.31
Côte d'Ivoire	1701.43	131.60	40.46	1.59	1.32
Côte d'Ivoire	1654.86	146.40	40.84	1.41	1.33
Côte d'Ivoire	1711.11	177.90	41.21	1.93	1.35
Côte d'Ivoire	1779.74	156.50	41.59	1.49	1.36
Côte d'Ivoire	1884.72	164.60	41.96	2.30	1.38
Côte d'Ivoire	1900.21	177.70	42.34	3.87	1.40
Côte d'Ivoire	1865.12	167.20	42.74	1.25	1.41
Côte d'Ivoire	1809.92	165.10	43.16	1.42	1.43
Côte d'Ivoire	1725.16	173.30	43.57	1.62	1.44
Côte d'Ivoire	1636.45	165.60	43.98	1.18	1.45
Côte d'Ivoire	1521.88	163.90	44.40	0.78	1.46
Côte d'Ivoire	1534.08	155.40	44.82	1.20	1.47
Côte d'Ivoire	1514.62	151.70	45.23	1.45	1.48
Côte d'Ivoire	1523.23	161.50	45.65	1.39	1.49
Côte d'Ivoire	1507.09	167.30	46.07	1.54	1.50
Côte d'Ivoire	1545.88	175.30	46.49	1.37	1.51
Côte d'Ivoire	1568.02	182.50	46.91	1.17	1.52
Côte d'Ivoire	1640.32	195.40	47.33	1.03	1.53
Côte d'Ivoire	1520.34	177.80	47.75	0.82	1.55
Côte d'Ivoire	1602.91	212.60	48.17	0.91	1.57
Côte d'Ivoire	1739.16	209.10	48.59	0.95	1.58
Côte d'Ivoire	1858.62	249.20	49.01	0.90	1.60
Côte d'Ivoire	1941.58	234.80	49.44	1.08	1.62
Côte d'Ivoire	2027.83	232.10	49.88	1.19	1.64
Côte d'Ivoire	2122.50	265.80	50.33	1.86	1.66
Côte d'Ivoire	2168.91	259.90	50.78	1.06	1.68
Côte d'Ivoire	2252.54	263.50	51.24	1.42	1.70
Côte d'Ivoire	2234.91	282.90	51.71	1.13	1.70
Côte d'Ivoire	2333.35	290.30	52.18	1.94	1.71
Côte d'Ivoire	2333.35	290.30	52.18	1.94	1.71
Ghana	852.42	378.30	36.44	0.25	1.87
Ghana	874.99	395.40	37.17	0.30	1.90
Ghana	886.65	410.90	37.91	0.35	1.93
Ghana	907.20	384.80	38.64	2.09	1.96
Ghana	915.29	360.40	39.39	4.28	1.99
Ghana	931.18	353.70	40.14	1.65	2.02
Ghana	951.92	375.10	40.90	1.73	2.04

Ghana	968.85	374.90	41.65	1.19	2.06
Ghana	990.18	297.70	42.42	2.24	2.08
Ghana	1008.83	323.80	43.18	3.16	2.10
Ghana	1020.16	302.80	43.93	3.33	2.12
Ghana	1033.12	346.80	44.60	1.68	2.13
Ghana	1050.34	291.20	45.28	0.96	2.14
Ghana	1075.37	219.70	45.95	1.79	2.16
Ghana	1105.69	215.30	46.63	1.57	2.17
Ghana	1140.19	244.60	47.31	1.35	2.18
Ghana	1181.56	292.40	47.99	3.05	2.20
Ghana	1201.21	240.80	48.67	5.57	2.21
Ghana	1277.82	263.90	49.35	9.47	2.23
Ghana	1306.19	262.10	50.03	9.11	2.24
Ghana	1374.99	286.70	50.71	7.85	2.26
Ghana	1530.36	345.40	51.39	8.26	2.29
Ghana	1631.92	376.80	52.07	7.98	2.32
Ghana	1708.83	391.40	52.75	5.14	2.35
Ghana	1715.82	384.70	53.42	6.14	2.37
Ghana	1711.27	368.20	54.09	6.46	2.40
Ghana	1728.10	391.00	54.75	6.21	2.43
Ghana	1827.27	417.50	55.41	5.39	2.46
Ghana	1899.81	425.80	56.06	4.44	2.50
Ghana	1981.61	471.10	56.71	5.68	2.52
Ghana	1951.06	557.60	57.35	2.68	2.56
Ghana	2014.71	582.10	57.99	3.30	2.57
Ghana	2014.71	582.10	57.99	3.30	2.57
Kenya	1313.86	130.90	16.75	0.67	1.71
Kenya	1290.63	132.10	17.04	0.23	1.73
Kenya	1242.02	128.00	17.34	0.08	1.75
Kenya	1210.27	136.30	17.65	2.53	1.77
Kenya	1206.87	133.50	17.95	0.10	1.79
Kenya	1225.14	135.50	18.26	0.47	1.82
Kenya	1241.88	137.00	18.58	0.90	1.84
Kenya	1214.85	133.70	18.90	0.47	1.86
Kenya	1221.52	134.40	19.22	0.19	1.89
Kenya	1215.16	120.40	19.55	0.40	1.91
Kenya	1187.33	114.70	19.89	0.87	1.94
Kenya	1195.44	126.10	20.24	0.04	1.96
Kenya	1166.07	126.10	20.59	0.21	1.98
Kenya	1165.17	135.80	20.95	0.55	2.00
Kenya	1188.57	141.10	21.31	0.29	2.02

Kenya	1221.86	143.30	21.68	0.11	2.05
Kenya	1262.81	149.60	22.05	0.20	2.07
Kenya	1309.90	150.60	22.42	2.28	2.09
Kenya	1274.40	145.20	22.80	0.27	2.12
Kenya	1278.14	146.40	23.18	0.27	2.14
Kenya	1342.77	159.50	23.57	0.39	2.17
Kenya	1374.54	161.80	23.97	3.09	2.19
Kenya	1401.49	165.50	24.38	2.45	2.20
Kenya	1420.08	174.10	24.79	1.81	2.22
Kenya	1457.54	160.30	25.22	1.20	2.24
Kenya	1496.65	190.30	25.66	0.88	2.26
Kenya	1525.74	175.40	26.11	0.63	2.28
Kenya	1550.20	198.10	26.56	1.64	2.31
Kenya	1604.80	191.10	27.03	0.83	2.33
Kenya	1653.83	187.50	27.51	0.47	2.35
Kenya	1616.50	174.70	28.00	0.42	2.44
Kenya	1705.74	171.00	28.49	0.42	2.45
Kenya	1705.74	171.00	28.49	0.42	2.45
Mauritius	3810.48	631.40	43.90	1.55	2.04
Mauritius	3936.77	684.00	43.78	0.61	2.06
Mauritius	4138.35	750.70	43.65	0.46	2.09
Mauritius	4297.41	791.80	43.53	0.45	2.11
Mauritius	4412.94	813.90	43.41	0.56	2.13
Mauritius	4562.75	878.60	43.28	0.46	2.16
Mauritius	4768.68	758.60	43.16	0.83	2.18
Mauritius	4977.19	869.20	43.04	1.32	2.21
Mauritius	5224.18	893.90	42.92	0.29	2.23
Mauritius	5292.87	1067.70	42.79	1.14	2.26
Mauritius	5671.03	1281.60	42.67	5.70	2.28
Mauritius	5814.75	1361.80	42.56	-0.60	2.30
Mauritius	5867.77	1382.80	42.45	0.66	2.32
Mauritius	6170.65	1470.70	42.34	1.08	2.34
Mauritius	6397.59	1520.00	42.22	0.21	2.36
Mauritius	6472.87	1580.70	42.11	0.64	2.38
Mauritius	6756.23	1632.90	42.00	1.52	2.40
Mauritius	7110.69	1700.10	41.89	4.18	2.42
Mauritius	7466.69	1786.30	41.78	3.78	2.44
Mauritius	7693.76	1812.70	41.67	2.81	2.46
Mauritius	8011.46	1897.50	41.56	4.30	2.48
Mauritius	8324.78	1921.10	41.44	3.76	2.50
Mauritius	8591.97	1958.50	41.33	5.05	2.52

Mauritius	8859.21	2037.70	41.22	2.39	2.54
Mauritius	9181.62	2073.20	41.11	3.48	2.56
Mauritius	9507.87	2122.00	41.00	1.80	2.57
Mauritius	9868.33	2156.90	40.91	3.01	2.59
Mauritius	10247.70	2200.10	40.84	3.50	2.60
Mauritius	10652.48	2211.20	40.79	3.13	2.62
Mauritius	10956.95	2296.10	40.77	3.08	2.63
Mauritius	9357.30	2048.40	40.76	1.97	2.67
Mauritius	9672.95	2287.50	40.78	2.21	2.72
Mauritius	9672.95	2287.50	40.78	2.21	2.72
Namibia	2857.95	435.70	27.66	1.06	2.01
Namibia	2989.54	320.70	27.92	4.02	2.01
Namibia	3103.47	219.90	28.34	3.45	2.01
Namibia	2957.05	502.00	28.82	1.70	2.02
Namibia	2914.36	377.70	29.32	2.67	2.02
Namibia	2939.49	1084.10	29.81	3.85	2.02
Namibia	2951.14	1054.20	30.32	3.23	2.02
Namibia	2997.25	972.90	30.82	2.19	2.01
Namibia	3019.74	730.90	31.34	2.48	2.01
Namibia	3047.19	945.20	31.85	1.32	2.01
Namibia	3082.76	967.70	32.37	5.01	2.00
Namibia	3056.47	1061.00	32.90	10.66	2.02
Namibia	3148.35	1324.20	33.77	4.41	2.03
Namibia	3235.75	1386.10	34.71	1.32	2.05
Namibia	3587.84	1550.20	35.67	3.38	2.07
Namibia	3634.62	1512.50	36.63	5.38	2.08
Namibia	3845.29	1626.00	37.61	7.63	2.09
Namibia	4001.71	1624.90	38.60	7.57	2.10
Namibia	4053.22	1689.70	39.60	8.72	2.12
Namibia	4007.49	1631.00	40.60	9.27	2.13
Namibia	4186.04	1607.90	41.62	2.52	2.14
Namibia	4330.94	1595.20	42.64	6.42	2.15
Namibia	4476.41	1553.10	43.69	7.99	2.16
Namibia	4648.32	1727.40	44.76	6.45	2.17
Namibia	4846.89	1683.70	45.83	3.58	2.19
Namibia	4965.67	1669.90	46.90	7.40	2.20
Namibia	4880.45	1701.90	47.96	3.35	2.21
Namibia	4746.18	1744.30	49.01	2.18	2.23
Namibia	4714.45	1823.20	50.03	1.71	2.24
Namibia	4596.62	1783.30	51.04	-1.41	2.25
Namibia	4152.18	1533.90	52.03	-1.42	2.28
Namibia	4228.78	1346.80	53.01	5.55	2.31

Namibia	4228.78	1346.80	53.01	5.55	2.31
Nigeria	1608.78	84.30	29.68	1.09	1.22
Nigeria	1573.70	83.90	30.18	1.45	1.24
Nigeria	1605.55	84.10	30.68	1.88	1.27
Nigeria	1533.18	80.60	31.18	4.85	1.29
Nigeria	1467.09	75.90	31.69	5.79	1.31
Nigeria	1429.01	73.30	32.21	0.76	1.34
Nigeria	1451.82	69.00	32.73	0.98	1.36
Nigeria	1457.23	69.50	33.25	0.86	1.38
Nigeria	1457.70	73.50	33.77	0.55	1.41
Nigeria	1429.41	70.10	34.30	1.69	1.43
Nigeria	1462.54	91.40	34.84	1.64	1.46
Nigeria	1508.55	93.50	35.67	1.61	1.49
Nigeria	1693.75	127.00	36.51	1.97	1.52
Nigeria	1769.88	115.90	37.36	1.91	1.55
Nigeria	1882.18	135.70	38.21	1.38	1.58
Nigeria	1950.12	128.30	39.07	2.84	1.61
Nigeria	2013.27	122.30	39.94	2.04	1.64
Nigeria	2088.60	126.30	40.82	2.17	1.67
Nigeria	2170.06	113.00	41.70	2.41	1.71
Nigeria	2281.39	102.80	42.59	2.90	1.73
Nigeria	2397.32	132.30	43.48	1.64	1.76
Nigeria	2455.75	133.10	44.37	2.13	1.78
Nigeria	2490.21	137.50	45.25	1.52	1.80
Nigeria	2585.65	132.30	46.12	1.07	1.83
Nigeria	2677.49	143.70	46.98	0.82	1.85
Nigeria	2679.55	140.40	47.84	0.62	1.88
Nigeria	2570.96	140.60	48.68	0.85	1.90
Nigeria	2527.00	144.50	49.52	0.64	1.92
Nigeria	2512.08	135.40	50.34	0.18	1.95
Nigeria	2505.46	131.20	51.16	0.49	1.97
Nigeria	2401.18	119.40	51.96	0.55	1.99
Nigeria	2429.59	124.60	52.75	0.75	2.00
Nigeria	2429.59	124.60	52.75	0.75	2.00
South Africa	4643.22	3932.90	52.04	-0.06	1.91
South Africa	4479.85	3880.60	52.55	0.19	1.92
South Africa	4294.90	3714.90	53.04	0.00	1.94
South Africa	4269.70	3736.00	53.52	0.01	1.96
South Africa	4330.71	3799.30	54.00	0.24	1.98
South Africa	4392.07	3902.20	54.49	0.73	1.99
South Africa	4511.64	3917.90	54.97	0.50	2.01

South Africa	4565.22	4015.80	55.45	2.26	2.03
South Africa	4531.30	3947.80	55.93	0.36	2.05
South Africa	4588.76	3930.60	56.41	0.99	2.07
South Africa	4735.67	4024.10	56.89	0.64	2.09
South Africa	4820.64	3943.00	57.37	5.37	2.12
South Africa	4953.74	4099.90	57.90	1.15	2.16
South Africa	5052.91	4156.50	58.45	0.40	2.20
South Africa	5233.87	4189.30	58.99	0.27	2.24
South Africa	5458.23	4244.60	59.54	2.26	2.29
South Africa	5708.82	4330.00	60.08	0.21	2.33
South Africa	5954.17	4489.70	60.62	1.98	2.37
South Africa	6074.94	4290.10	61.15	3.13	2.41
South Africa	5910.79	4048.00	61.69	2.31	2.46
South Africa	6018.23	4189.50	62.22	0.88	2.50
South Africa	6130.97	4189.30	62.75	0.90	2.56
South Africa	6194.99	4016.90	63.27	1.06	2.60
South Africa	6263.10	3935.70	63.79	2.05	2.64
South Africa	6252.32	3883.70	64.31	1.52	2.68
South Africa	6204.93	3778.80	64.83	0.44	2.72
South Africa	6185.75	3681.30	65.34	0.68	2.76
South Africa	6233.19	3647.70	65.85	0.54	2.81
South Africa	6251.00	3593.50	66.36	1.38	2.86
South Africa	6189.29	3486.40	66.86	1.32	2.91
South Africa	5726.26	3193.60	67.35	0.93	3.98
South Africa	5947.89	3183.10	67.85	9.70	4.01
South Africa	5947.89	3191.10	67.85	9.70	4.01

Dependent Variable: D(LCO2)
Method: ARDL
Date: 12/07/23 Time: 15:28
Sample: 1992 2021
Included observations: 210
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): CPS LLR MKT SMT LGDPPC LENC URB FDI SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
CPS	0.002171	0.003793	0.572324	0.5688
LLR	-0.016798	0.004064	-4.133026	0.0001
MKT	-0.102024	0.024095	-4.234219	0.0001
SMT	0.019504	0.005131	3.801473	0.0003
LGDPPC	0.819053	0.189137	4.330486	0.0000
LENC	0.177631	0.058731	3.024509	0.0034
URB	0.075675	0.018624	4.063247	0.0001
FDI	0.004309	0.011084	0.388731	0.6986
SER	-0.417497	0.583274	-0.715781	0.4763
Short Run Equation				
COINTEQ01	-0.511009	0.177306	-2.882081	0.0052
D(CPS)	0.005650	0.006380	0.885690	0.3786
D(CPS(-1))	-0.003081	0.004552	-0.676914	0.5005
D(LLR)	-0.011995	0.005662	-2.118325	0.0375
D(LLR(-1))	-0.000596	0.001709	-0.348812	0.7282
D(MKT)	0.065631	0.039639	1.655708	0.1020
D(MKT(-1))	0.096711	0.071672	1.349365	0.1813
D(SMT)	-0.008827	0.007123	-1.239315	0.2191
D(SMT(-1))	-0.015977	0.007664	-2.084734	0.0405
D(LGDPPC)	0.134996	0.545936	0.247275	0.8054
D(LGDPPC(-1))	0.236947	0.357135	0.663465	0.5091
D(LENC)	0.330131	0.267049	1.236219	0.2202
D(LENC(-1))	0.276804	0.185676	1.490790	0.1402
D(URB)	3.655294	2.434897	1.501211	0.1375
D(URB(-1))	-3.517741	2.425405	-1.450373	0.1511
D(FDI)	0.006984	0.012722	0.548972	0.5847
D(FDI(-1))	0.000259	0.012670	0.020405	0.9838
D(SER)	3.688217	2.978836	1.238140	0.2195
D(SER(-1))	4.828271	4.879431	0.989515	0.3256
C	3.172192	1.081277	2.933747	0.0044

Mean dependent var	0.037861	S.D. dependent var	0.119277
S.E. of regression	0.087929	Akaike info criterion	-1.851007
Sum squared resid	0.579858	Schwarz criterion	0.418347
Log likelihood	356.3127	Hannan-Quinn criter.	-0.934985

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(EFPC)
Method: ARDL
Date: 12/07/23 Time: 15:32
Sample: 1992 2021
Included observations: 210
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): CPS LLR MKT SMT LGDPPC LENC URB FDI SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
CPS	0.002605	0.000864	3.015631	0.0035
LLR	0.000781	0.000737	1.059410	0.2928
MKT	-0.006216	0.000774	-8.035332	0.0000
SMT	-0.008829	0.001310	-6.738046	0.0000
LGDPPC	0.044592	0.079235	0.562780	0.5753
LENC	0.080355	0.035808	2.244074	0.0278
URB	0.028059	0.003418	8.209161	0.0000
FDI	0.003101	0.001397	2.219771	0.0295
SER	-0.687136	0.078349	-8.770247	0.0000
		Short Run Equation		
COINTEQ01	-0.659227	0.163097	-4.041941	0.0001
D(CPS)	-0.002695	0.001642	-1.640682	0.1051
D(CPS(-1))	-0.002844	0.001872	-1.518595	0.1331
D(LLR)	0.002487	0.003805	0.653701	0.5153
D(LLR(-1))	-0.003121	0.005392	-0.578799	0.5645
D(MKT)	-0.015170	0.011371	-1.334069	0.1862
D(MKT(-1))	-0.005218	0.004934	-1.057513	0.2937
D(SMT)	0.003714	0.003543	1.048376	0.2978
D(SMT(-1))	0.005671	0.003900	1.454114	0.1501
D(LGDPPC)	1.490435	0.636521	2.341534	0.0219
D(LGDPPC(-1))	0.697853	0.453926	1.537372	0.1284
D(LENC)	-0.270495	0.234037	-1.155778	0.2514
D(LENC(-1))	-0.279303	0.261566	-1.067811	0.2890
D(URB)	0.677563	0.545850	1.241299	0.2184
D(URB(-1))	-1.507853	0.736154	-2.048283	0.0440
D(FDI)	-0.010621	0.007181	-1.479025	0.1433
D(FDI(-1))	-0.004054	0.004384	-0.924733	0.3581
D(SER)	3.774446	3.781557	0.998120	0.3214
D(SER(-1))	-1.147507	3.841147	-0.298741	0.7660
C	0.029582	0.211238	0.140042	0.8890

Mean dependent var	0.000473	S.D. dependent var	0.077862
S.E. of regression	0.049034	Akaike info criterion	-3.240954
Sum squared resid	0.180328	Schwarz criterion	-0.971600
Log likelihood	511.9868	Hannan-Quinn criter.	-2.324932

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(EFPI)
Method: ARDL
Date: 12/07/23 Time: 15:39
Sample: 1992 2021
Included observations: 210
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): CPS LLR MKT SMT LGDPPC LENC URB FDI SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
CPS	-0.050753	0.020694	-2.452535	0.0165
LLR	-0.063194	0.027127	-2.329550	0.0225
MKT	0.091393	0.038287	2.387076	0.0195
SMT	-0.187039	0.068502	-2.730403	0.0079
LGDPPC	8.022877	3.282341	2.444255	0.0169
LENC	-4.658689	1.750486	-2.661369	0.0095
URB	0.141606	0.088768	1.595238	0.1149
FDI	-0.235013	0.085169	-2.759380	0.0073
SER	-10.57224	4.456805	-2.372158	0.0203
		Short Run Equation		
COINTEQ01	-0.010422	0.067933	-0.153416	0.8785
D(CPS)	-0.005847	0.003590	-1.628649	0.1076
D(CPS(-1))	-0.004046	0.009083	-0.445485	0.6573
D(LLR)	0.018575	0.018227	1.019077	0.3114
D(LLR(-1))	-0.014280	0.007031	-2.031054	0.0458
D(MKT)	-0.064633	0.044442	-1.454346	0.1500
D(MKT(-1))	-0.116962	0.100791	-1.160443	0.2495
D(SMT)	0.042806	0.048762	0.877856	0.3828
D(SMT(-1))	0.078862	0.077563	1.016748	0.3125
D(LGDPPC)	8.579123	6.674583	1.285342	0.2026
D(LGDPPC(-1))	-5.895800	6.534117	-0.902310	0.3698
D(LENC)	-0.624091	0.514711	-1.212507	0.2291
D(LENC(-1))	0.152116	0.929001	0.163742	0.8704
D(URB)	-6.678146	6.618149	-1.009066	0.3162
D(URB(-1))	-0.768948	1.054390	-0.729282	0.4681
D(FDI)	-0.038952	0.028315	-1.375676	0.1730
D(FDI(-1))	0.027111	0.035026	0.774033	0.4413
D(SER)	27.35753	24.87074	1.099988	0.2749
D(SER(-1))	-48.49359	43.72562	-1.109043	0.2710
C	0.510319	1.206054	0.423131	0.6734

Mean dependent var	-0.046716	S.D. dependent var	0.528255
S.E. of regression	0.401431	Akaike info criterion	-2.710778
Sum squared resid	12.08602	Schwarz criterion	-0.441424
Log likelihood	452.6071	Hannan-Quinn criter.	-1.794756

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(LCO2)
Method: ARDL
Date: 12/07/23 Time: 16:17
Sample: 1991 2021
Included observations: 217
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGDPPC LGDPPC2 LGDPPC3 LENC URB FDI SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
LGDPPC	254.7029	29.82352	8.540337	0.0000
LGDPPC2	32.05577	3.775995	8.489357	0.0000
LGDPPC3	-1.337004	0.158535	-8.433520	0.0000
LENC	0.921055	0.129384	7.118771	0.0000
URB	0.018705	0.006657	2.809980	0.0056
FDI	-0.014186	0.008496	-1.669784	0.0970
SER	0.104664	0.070846	1.477335	0.1416
		Short Run Equation		
COINTEQ01	-0.516805	0.180421	-2.864436	0.0048
D(LGDPPC)	1572.241	721.8229	2.178153	0.0309
D(LGDPPC2)	-206.2750	95.53673	-2.159117	0.0324
D(LGDPPC3)	9.042748	4.232329	2.136589	0.0342
D(LENC)	-0.190995	0.103148	-1.851658	0.0660
D(URB)	0.586332	0.326647	1.795001	0.0746
D(FDI)	0.021046	0.009173	2.294458	0.0231
D(SER)	-1.024998	2.145096	-0.477833	0.6334
C	-341.1974	118.9458	-2.868512	0.0047

Mean dependent var	0.036812	S.D. dependent var	0.118861
S.E. of regression	0.095930	Akaike info criterion	-1.810383
Sum squared resid	1.417202	Schwarz criterion	-0.744244
Log likelihood	272.7629	Hannan-Quinn criter.	-1.380037

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(EFPC)
Method: ARDL
Date: 12/07/23 Time: 16:19
Sample: 1992 2021
Included observations: 210
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGDPPC LGDPPC2 LGDPPC3 LENC URB FDI SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
LGDPPC	24.07569	8.038812	2.994931	0.0034
LGDPPC2	2.956994	1.026805	2.879801	0.0048
LGDPPC3	-0.120908	0.043439	-2.783381	0.0064
LENC	-0.026474	0.021020	-1.259471	0.2107
URB	-0.005067	0.003887	-1.303705	0.1952
FDI	0.006059	0.001672	3.622828	0.0005
SER	0.167298	0.090691	1.844704	0.0679
		Short Run Equation		
COINTEQ01	-0.886878	0.164262	-5.399176	0.0000
D(LGDPPC)	1968.098	2349.436	0.837690	0.4041
D(LGDPPC(-1))	-1385.162	918.4837	-1.508097	0.1345
D(LGDPPC2)	-227.9465	274.4911	-0.830433	0.4082
D(LGDPPC2(-1))	169.0848	106.4866	1.587851	0.1153
D(LGDPPC3)	8.815555	10.69062	0.824607	0.4115
D(LGDPPC3(-1))	-6.903003	4.110831	-1.679223	0.0961
D(LENC)	-0.252733	0.285418	-0.885484	0.3779
D(LENC(-1))	-0.299188	0.235972	-1.267895	0.2076
D(URB)	0.247775	0.263708	0.939581	0.3496
D(URB(-1))	-0.679163	0.283410	-2.396396	0.0183
D(FDI)	-0.010924	0.003979	-2.745241	0.0071
D(FDI(-1))	-0.008047	0.005971	-1.347812	0.1806
D(SER)	-0.311174	2.774212	-0.112166	0.9109
D(SER(-1))	-1.707672	1.435727	-1.189412	0.2370
C	-57.20104	10.64149	-5.375286	0.0000

Mean dependent var	0.000473	S.D. dependent var	0.077862
S.E. of regression	0.051263	Akaike info criterion	-3.044408
Sum squared resid	0.275925	Schwarz criterion	-1.231971
Log likelihood	459.9737	Hannan-Quinn criter.	-2.312820

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(EFPI)
Method: ARDL
Date: 12/07/23 Time: 16:19
Sample: 1992 2021
Included observations: 210
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGDPPC LGDPPC2 LGDPPC3 LENC URB FDI SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
LGDPPC	-303.6214	29.57524	-10.26607	0.0000
LGDPPC2	39.30877	3.802493	10.33763	0.0000
LGDPPC3	-1.689906	0.161935	-10.43571	0.0000
LENC	-0.021645	0.059242	-0.365365	0.7156
URB	0.058465	0.012343	4.736633	0.0000
FDI	0.039307	0.004343	9.051131	0.0000
SER	-0.037618	0.191645	-0.196289	0.8448
		Short Run Equation		
COINTEQ01	-0.560424	0.204645	-2.738518	0.0073
D(LGDPPC)	2380.517	2796.479	0.851255	0.3966
D(LGDPPC(-1))	806.6130	871.7456	0.925285	0.3569
D(LGDPPC2)	-278.7585	330.3290	-0.843881	0.4007
D(LGDPPC2(-1))	-86.73855	105.9996	-0.818291	0.4150
D(LGDPPC3)	10.99575	12.99330	0.846263	0.3993
D(LGDPPC3(-1))	3.076427	4.337499	0.709263	0.4797
D(LENC)	0.028323	0.110607	0.256070	0.7984
D(LENC(-1))	-0.689639	0.489760	-1.408117	0.1621
D(URB)	3.709898	5.015054	0.739752	0.4611
D(URB(-1))	-4.923797	5.946823	-0.827971	0.4096
D(FDI)	-0.072699	0.057261	-1.269619	0.2070
D(FDI(-1))	-0.053026	0.050295	-1.054300	0.2942
D(SER)	-29.49963	32.52914	-0.906868	0.3666
D(SER(-1))	2.787946	8.422277	0.331020	0.7413
C	437.8792	160.1115	2.734839	0.0073

Mean dependent var	-0.046716	S.D. dependent var	0.528255
S.E. of regression	0.275223	Akaike info criterion	-2.906220
Sum squared resid	7.953522	Schwarz criterion	-1.093783
Log likelihood	444.4966	Hannan-Quinn criter.	-2.174632

*Note: p-values and any subsequent tests do not account for model selection.

Pairwise Dumitrescu Hurlin Panel Causality Tests
Date: 12/07/23 Time: 16:20
Sample: 1990 2021
Lags: 2

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
EFPC does not homogeneously cause LCO2	1.54416	-0.70245	0.4824
LCO2 does not homogeneously cause EFPC	7.14504	5.54500	3.E-08
EFPI does not homogeneously cause LCO2	1.43790	-0.82098	0.4117
LCO2 does not homogeneously cause EFPI	5.64359	3.87022	0.0001
MKT does not homogeneously cause LCO2	0.97987	-1.33188	0.1829
LCO2 does not homogeneously cause MKT	3.19978	1.14430	0.2525
SMT does not homogeneously cause LCO2	2.36377	0.21178	0.8323
LCO2 does not homogeneously cause SMT	2.43384	0.28993	0.7719
CPS does not homogeneously cause LCO2	2.99562	0.91656	0.3594
LCO2 does not homogeneously cause CPS	7.06912	5.46031	5.E-08
LLR does not homogeneously cause LCO2	2.17531	0.00156	0.9988
LCO2 does not homogeneously cause LLR	5.13040	3.29779	0.0010
EFPI does not homogeneously cause EFPC	5.79816	4.04263	5.E-05
EFPC does not homogeneously cause EFPI	4.33327	2.40863	0.0160
MKT does not homogeneously cause EFPC	4.23894	2.30342	0.0213
EFPC does not homogeneously cause MKT	3.73786	1.74449	0.0811
SMT does not homogeneously cause EFPC	3.71487	1.71885	0.0856
EFPC does not homogeneously cause SMT	3.24820	1.19830	0.2308
CPS does not homogeneously cause EFPC	5.46964	3.67619	0.0002
EFPC does not homogeneously cause CPS	1.06724	-1.23442	0.2170
LLR does not homogeneously cause EFPC	6.78103	5.13896	3.E-07
EFPC does not homogeneously cause LLR	2.18289	0.01001	0.9920
MKT does not homogeneously cause EFPI	2.11363	-0.06724	0.9464
EFPI does not homogeneously cause MKT	3.34363	1.30476	0.1920
SMT does not homogeneously cause EFPI	1.45416	-0.80285	0.4221
EFPI does not homogeneously cause SMT	3.33251	1.29235	0.1962
CPS does not homogeneously cause EFPI	3.20152	1.14623	0.2517
EFPI does not homogeneously cause CPS	0.76151	-1.57545	0.1152
LLR does not homogeneously cause EFPI	4.15104	2.20537	0.0274
EFPI does not homogeneously cause LLR	1.07465	-1.22616	0.2201
SMT does not homogeneously cause MKT	3.46609	1.44135	0.1495
MKT does not homogeneously cause SMT	14.3769	13.6117	0.0000

CPS does not homogeneously cause MKT	1.82640	-0.38763	0.6983
MKT does not homogeneously cause CPS	5.00794	3.16119	0.0016
LLR does not homogeneously cause MKT	2.78140	0.67762	0.4980
MKT does not homogeneously cause LLR	1.97047	-0.22693	0.8205
CPS does not homogeneously cause SMT	3.84175	1.86037	0.0628
SMT does not homogeneously cause CPS	3.96761	2.00076	0.0454
LLR does not homogeneously cause SMT	3.37200	1.33639	0.1814
SMT does not homogeneously cause LLR	3.41989	1.38981	0.1646
LLR does not homogeneously cause CPS	1.79817	-0.41912	0.6751
CPS does not homogeneously cause LLR	2.76300	0.65709	0.5111

Dependent Variable: D(LCO2)
Method: ARDL
Date: 12/07/23 Time: 16:35
Sample: 1992 2021
Included observations: 210
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGDPPC LLR LLR_LGDPPC LENC FDI URB SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
LGDPPC	-0.434679	0.174607	-2.489468	0.0144
LLR	-0.046982	0.022906	-2.051030	0.0428
LLR_LGDPPC	0.005009	0.002439	2.097902	0.0405
LENC	1.696671	0.164342	10.32404	0.0000
FDI	0.020366	0.010143	2.007933	0.0472
URB	0.032180	0.010037	3.206193	0.0018
SER	0.218193	0.197970	1.102147	0.2729
		Short Run Equation		
COINTEQ01	-0.620180	0.237633	-2.609817	0.0104
D(LGDPPC)	1.525051	1.085927	1.404377	0.1632
D(LGDPPC(-1))	-1.661982	1.122255	-1.480931	0.1416
D(LLR)	0.192116	0.268900	0.714450	0.4765
D(LLR(-1))	-0.529810	0.205232	-2.581519	0.0112
D(LLR_LGDPPC)	-0.023151	0.035402	-0.653950	0.5146
D(LLR_LGDPPC(-1))	0.071237	0.027506	2.589845	0.0110
D(LENC)	-0.256852	0.176534	-1.454976	0.1487
D(LENC(-1))	-0.040024	0.133743	-0.299261	0.7653
D(FDI)	0.007531	0.012435	0.605621	0.5461
D(FDI(-1))	0.004609	0.010851	0.424789	0.6719
D(URB)	1.144351	1.958154	0.584403	0.5602
D(URB(-1))	-2.523518	2.100833	-1.201199	0.2324
D(SER)	-6.625576	5.715570	-1.159215	0.2490
D(SER(-1))	7.747683	5.878642	1.317938	0.1904
C	6.498452	2.724489	2.385200	0.0189

Mean dependent var	0.037861	S.D. dependent var	0.119277
S.E. of regression	0.091333	Akaike info criterion	-1.776477
Sum squared resid	0.875872	Schwarz criterion	0.035960
Log likelihood	317.9654	Hannan-Quinn criter.	-1.044889

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(LCO2)
Method: ARDL
Date: 12/07/23 Time: 16:36
Sample: 1991 2021
Included observations: 217
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGDPPC CPS CPS_LGDPPC LENC FDI URB SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
LGDPPC	0.920640	0.196832	4.677281	0.0000
CPS	0.053356	0.027680	1.927560	0.0558
CPS_LGDPPC	-0.007643	0.003348	-2.282576	0.0238
LENC	0.186549	0.065907	2.830499	0.0053
FDI	-0.000278	0.007379	-0.037635	0.9700
URB	0.049728	0.010828	4.592715	0.0000
SER	-0.039348	0.344781	-0.114123	0.9093
		Short Run Equation		
COINTEQ01	-0.431368	0.126797	-3.402036	0.0009
D(LGDPPC)	-0.222587	0.702148	-0.317009	0.7517
D(CPS)	-0.275776	0.194703	-1.416392	0.1587
D(CPS_LGDPPC)	0.037813	0.026141	1.446505	0.1501
D(LENC)	0.079967	0.159953	0.499938	0.6178
D(FDI)	0.010164	0.005454	1.863514	0.0643
D(URB)	-0.139845	0.426259	-0.328075	0.7433
D(SER)	0.694665	1.355280	0.512562	0.6090
C	2.605003	0.719907	3.618525	0.0004

Mean dependent var	0.036812	S.D. dependent var	0.118861
S.E. of regression	0.099334	Akaike info criterion	-1.726408
Sum squared resid	1.519570	Schwarz criterion	-0.660268
Log likelihood	263.3577	Hannan-Quinn criter.	-1.296062

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(LCO2)
Method: ARDL
Date: 12/07/23 Time: 16:37
Sample: 1991 2021
Included observations: 217
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGDPPC MKT MKC_LGDPPC LENC FDI URB SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
LGDPPC	0.500878	0.220858	2.267872	0.0247
MKT	0.364040	0.405313	0.898170	0.3705
MKC_LGDPPC	-0.056767	0.027146	-2.076224	0.0435
LENC	0.278212	0.054415	5.112830	0.0000
FDI	-0.004560	0.006947	-0.656388	0.5126
URB	0.006459	0.007483	0.863165	0.3894
SER	1.268627	0.390044	3.252521	0.0014
		Short Run Equation		
COINTEQ01	-0.404936	0.097783	-4.141154	0.0001
D(LGDPPC)	0.421178	0.537721	0.783266	0.4347
D(MKT)	-1.790786	1.603413	-1.116859	0.2658
D(MKC_LGDPPC)	0.225246	0.200379	1.124099	0.2627
D(LENC)	0.076728	0.118141	0.649464	0.5170
D(FDI)	0.012198	0.005737	2.126174	0.0351
D(URB)	-0.214296	0.130612	-1.640708	0.1029
D(SER)	1.971295	1.308146	1.506938	0.1339
C	3.217828	0.801740	4.013554	0.0001

Mean dependent var	0.036812	S.D. dependent var	0.118861
S.E. of regression	0.098854	Akaike info criterion	-1.789317
Sum squared resid	1.504914	Schwarz criterion	-0.723177
Log likelihood	270.4035	Hannan-Quinn criter.	-1.358971

*Note: p-values and any subsequent tests do not account for model selection.

ependent Variable: D(LCO2)
Method: ARDL
Date: 12/07/23 Time: 16:38
Sample: 1991 2021
Included observations: 217
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGDPPC SMT SMT_LGDPPC LENC FDI URB SER
Fixed regressors: C
Number of models evalulated: 2
Selected Model: ARDL(1, 1, 1, 1, 1, 1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long Run Equation		
LGDPPC	0.282931	0.197436	1.433027	0.1539
SMT	-0.075247	0.076821	-0.979510	0.3289
SMT_LGDPPC	0.009024	0.009292	0.971137	0.3330
LENC	0.211314	0.053912	3.919589	0.0001
FDI	0.003644	0.007347	0.496014	0.6206
URB	0.018603	0.005986	3.107818	0.0022
SER	1.007749	0.359053	2.806684	0.0057
		Short Run Equation		
COINTEQ01	-0.450354	0.122586	-3.673765	0.0003
D(LGDPPC)	0.566328	0.415630	1.362579	0.1750
D(SMT)	0.100531	0.283397	0.354737	0.7233
D(SMT_LGDPPC)	-0.012873	0.038618	-0.333332	0.7393
D(LENC)	0.131124	0.122873	1.067156	0.2876
D(FDI)	0.008156	0.003292	2.477360	0.0143
D(URB)	-0.226981	0.163660	-1.386905	0.1675
D(SER)	0.643405	1.219692	0.527514	0.5986
C	4.432081	1.145165	3.870254	0.0002

Mean dependent var	0.036812	S.D. dependent var	0.118861
S.E. of regression	0.100876	Akaike info criterion	-1.658204
Sum squared resid	1.567105	Schwarz criterion	-0.592065
Log likelihood	255.7189	Hannan-Quinn criter.	-1.227858

*Note: p-values and any subsequent tests do not account for model selection.

Pairwise Dumitrescu Hurlin Panel Causality Tests
Date: 01/04/24 Time: 14:08
Sample: 1990 2021
Lags: 2

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
LCO2 does not homogeneously cause LGDPPC	3.42745	1.39824	0.1620
LGDPPC does not homogeneously cause LCO2	6.51258	4.83952	1.E-06
EFPC does not homogeneously cause LGDPPC	2.73971	0.63111	0.5280
LGDPPC does not homogeneously cause EFPC	8.33100	6.86787	7.E-12
EFPI does not homogeneously cause LGDPPC	3.06115	0.98966	0.3223
LGDPPC does not homogeneously cause EFPI	12.1608	11.1397	0.0000
EFPC does not homogeneously cause LCO2	1.54416	-0.70245	0.4824
LCO2 does not homogeneously cause EFPC	7.14504	5.54500	3.E-08
EFPI does not homogeneously cause LCO2	1.43790	-0.82098	0.4117
LCO2 does not homogeneously cause EFPI	5.64359	3.87022	0.0001
EFPI does not homogeneously cause EFPC	5.79816	4.04263	5.E-05
EFPC does not homogeneously cause EFPI	4.33327	2.40863	0.0160

Panel unit root test: Summary
Series: LCO2
Date: 01/21/24 Time: 00:24
Sample: 1990 2021
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*	-2.62549	0.0043	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.37793	0.4373	7	210
ADF - Fisher Chi-square	10.3141	0.7389	7	210
PP - Fisher Chi-square	9.71880	0.7824	7	217

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

Panel unit root test: Summary
Series: EFPC
Date: 01/21/24 Time: 00:25
Sample: 1990 2021
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*	0.21499	0.5851	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.52569	0.2996	7	210
ADF - Fisher Chi-square	17.3128	0.2399	7	210
PP - Fisher Chi-square	33.8521	0.0022	7	217

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

Panel unit root test: Summary
Series: EFPI
Date: 01/21/24 Time: 00:25
Sample: 1990 2021
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*	2.05915	0.0303	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.60076	0.2740	7	210
ADF - Fisher Chi-square	28.4108	0.0125	7	210
PP - Fisher Chi-square	43.5391	0.0001	7	217

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

Panel unit root test: Summary
Series: LLR
Date: 01/21/24 Time: 00:26
Sample: 1990 2021
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*	0.96295	0.8322	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.20622	0.8861	7	210
ADF - Fisher Chi-square	14.3703	0.4225	7	210
PP - Fisher Chi-square	14.6931	0.3995	7	217

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

Panel unit root test: Summary
Series: CPS
Date: 01/21/24 Time: 00:26
Sample: 1990 2021
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*	-2.58776	0.0048	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.38359	0.0832	7	210
ADF - Fisher Chi-square	21.1918	0.0968	7	210
PP - Fisher Chi-square	17.3303	0.2390	7	217

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

Panel unit root test: Summary
Series: MKT
Date: 01/21/24 Time: 00:26
Sample: 1990 2021
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*	-3.26381	0.0005	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-2.87157	0.0020	7	210
ADF - Fisher Chi-square	31.6538	0.0045	7	210
PP - Fisher Chi-square	38.6173	0.0004	7	217

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

Panel unit root test: Summary
Series: SMT
Date: 01/21/24 Time: 00:27
Sample: 1990 2021
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*	-4.27064	0.0000	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.35638	0.0000	7	210
ADF - Fisher Chi-square	46.9701	0.0000	7	210
PP - Fisher Chi-square	53.4201	0.0000	7	217

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

Panel unit root test: Summary
Series: LENC
Date: 01/21/24 Time: 00:27
Sample: 1990 2021
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*	-0.93701	0.1744	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.39805	0.9190	7	210
ADF - Fisher Chi-square	8.11125	0.8835	7	210
PP - Fisher Chi-square	6.53892	0.9510	7	217

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

Panel unit root test: Summary
Series: LGDPPC
Date: 01/21/24 Time: 00:27
Sample: 1990 2021
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*	0.17037	0.5676	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	2.92802	0.9983	7	210
ADF - Fisher Chi-square	4.03166	0.9953	7	210
PP - Fisher Chi-square	3.66920	0.9971	7	217

** 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: 01/21/24 Time: 00:28
Sample: 1990 2021
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*	-2.25327	0.0121	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.56325	0.0002	7	210
ADF - Fisher Chi-square	36.9648	0.0007	7	210
PP - Fisher Chi-square	52.6945	0.0000	7	217

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

Panel unit root test: Summary
Series: SER
Date: 01/21/24 Time: 00:29
Sample: 1990 2021
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*	-1.80703	0.0359	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	5.72094	0.8364	7	210
ADF - Fisher Chi-square	4.87445	0.9875	7	210
PP - Fisher Chi-square	0.64714	0.9938	7	217

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

Panel unit root test: Summary
Series: URB
Date: 01/21/24 Time: 00:29
Sample: 1990 2021
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*	0.06519	0.5260	7	210
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	3.60496	0.9998	7	210
ADF - Fisher Chi-square	4.61645	0.9905	7	210
PP - Fisher Chi-square	27.4186	0.0170	7	217

** 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(LCO2)
Date: 01/21/24 Time: 00:30
Sample: 1990 2021
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*	-7.60053	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-8.60861	0.0000	7	203
ADF - Fisher Chi-square	93.8514	0.0000	7	203
PP - Fisher Chi-square	176.186	0.0000	7	210

** 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(EFPC)
Date: 01/21/24 Time: 00:31
Sample: 1990 2021
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*	-10.5132	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-12.7749	0.0000	7	203
ADF - Fisher Chi-square	132.819	0.0000	7	203
PP - Fisher Chi-square	186.395	0.0000	7	210

** 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(EFPI)
Date: 01/21/24 Time: 00:31
Sample: 1990 2021
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*	-7.12926	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-13.2757	0.0000	7	203
ADF - Fisher Chi-square	138.880	0.0000	7	203
PP - Fisher Chi-square	209.380	0.0000	7	210

** 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(CPS)
Date: 01/21/24 Time: 00:31
Sample: 1990 2021
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*	-5.97602	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.84283	0.0000	7	203
ADF - Fisher Chi-square	74.9265	0.0000	7	203
PP - Fisher Chi-square	156.193	0.0000	7	210

** 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(LLR)
Date: 01/21/24 Time: 00:31
Sample: 1990 2021
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*	-5.03842	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.84352	0.0000	7	203
ADF - Fisher Chi-square	61.6547	0.0000	7	203
PP - Fisher Chi-square	125.720	0.0000	7	210

** 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(MKT)
Date: 01/21/24 Time: 00:32
Sample: 1990 2021
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*	-10.5147	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-11.0860	0.0000	7	203
ADF - Fisher Chi-square	123.621	0.0000	7	203
PP - Fisher Chi-square	188.389	0.0000	7	210

** 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(SMT)
Date: 01/21/24 Time: 00:32
Sample: 1990 2021
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*	-12.0638	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-11.4915	0.0000	7	203
ADF - Fisher Chi-square	128.542	0.0000	7	203
PP - Fisher Chi-square	189.447	0.0000	7	210

** 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(LENC)
Date: 01/21/24 Time: 00:32
Sample: 1990 2021
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*	-6.67029	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.78685	0.0000	7	203
ADF - Fisher Chi-square	72.2989	0.0000	7	203
PP - Fisher Chi-square	165.762	0.0000	7	210

** 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(LGDPPC)
Date: 01/21/24 Time: 00:32
Sample: 1990 2021
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*	-3.99733	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.28206	0.0005	7	203
ADF - Fisher Chi-square	34.1491	0.0020	7	203
PP - Fisher Chi-square	69.8546	0.0000	7	210

** 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: 01/21/24 Time: 00:33
Sample: 1990 2021
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*	-7.48790	0.0000	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-10.7463	0.0000	7	203
ADF - Fisher Chi-square	120.008	0.0000	7	203
PP - Fisher Chi-square	189.458	0.0000	7	210

** 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(SER)
Date: 01/21/24 Time: 00:33
Sample: 1990 2021
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*	4.03163	0.0237	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.63510	0.9490	7	203
ADF - Fisher Chi-square	7.61839	0.9082	7	203
PP - Fisher Chi-square	45.6203	0.0000	7	210

** 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(URB)
Date: 01/21/24 Time: 00:34
Sample: 1990 2021
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*	3.86442	0.0329	7	203
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	3.56143	0.9998	7	203
ADF - Fisher Chi-square	5.67305	0.9741	7	203
PP - Fisher Chi-square	6.83327	0.9409	7	210

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

Kao Residual Cointegration Test
Series: LCO2 LLR SMT MKT LENC LGDPPC FDI CPS
Date: 01/21/24 Time: 00:36
Sample: 1990 2021
Included observations: 224
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-3.409267	0.0003
Residual variance	0.013396	
HAC variance	0.007833	

Johansen Fisher Panel Cointegration Test
Series: LCO2 LLR SMT MKT LENC LGDPPC FDI CPS
Date: 01/21/24 Time: 00:36
Sample: 1990 2021
Included observations: 224
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	380.5	0.0000	159.7	0.0000
At most 1	198.9	0.0000	93.18	0.0000
At most 2	124.1	0.0000	55.40	0.0000
At most 3	75.86	0.0000	35.81	0.0011
At most 4	46.48	0.0000	22.87	0.0624
At most 5	31.72	0.0044	14.37	0.4228
At most 6	29.47	0.0090	18.93	0.1678
At most 7	36.31	0.0009	36.31	0.0009

* Probabilities are computed using asymptotic Chi-square distribution.

Kao Residual Cointegration Test
Series: EFPC LLR SMT MKT LENC LGDPPC FDI CPS
Date: 01/21/24 Time: 00:37
Sample: 1990 2021
Included observations: 224
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-2.430168	0.0075
Residual variance	0.005672	
HAC variance	0.002656	

Johansen Fisher Panel Cointegration Test
Series: EFPC LLR SMT MKT LENC LGDPPC FDI CPS
Date: 01/21/24 Time: 00:37
Sample: 1990 2021
Included observations: 224
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	450.6	0.0000	223.4	0.0000
At most 1	201.3	0.0000	93.62	0.0000
At most 2	120.9	0.0000	61.97	0.0000
At most 3	67.21	0.0000	33.50	0.0024
At most 4	40.23	0.0002	17.79	0.2167
At most 5	31.67	0.0045	15.43	0.3495
At most 6	28.29	0.0130	19.12	0.1605
At most 7	34.10	0.0020	34.10	0.0020

* Probabilities are computed using asymptotic Chi-square distribution.

Kao Residual Cointegration Test
Series: EFPI LLR SMT MKT LENC LGDPPC FDI CPS
Date: 01/21/24 Time: 00:38
Sample: 1990 2021
Included observations: 224
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-2.121609	0.0310
Residual variance	0.262263	
HAC variance	0.261075	

Johansen Fisher Panel Cointegration Test
Series: EFPI LLR SMT MKT LENC LGDPPC FDI CPS
Date: 01/21/24 Time: 00:38
Sample: 1990 2021
Included observations: 224
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 1

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	487.1	0.0000	215.7	0.0000
At most 1	211.1	0.0000	103.3	0.0000
At most 2	125.7	0.0000	63.06	0.0000
At most 3	71.53	0.0000	29.48	0.0090
At most 4	48.03	0.0000	35.05	0.0014
At most 5	22.61	0.0668	12.46	0.5691
At most 6	20.82	0.1064	14.52	0.4117
At most 7	30.35	0.0068	30.35	0.0068

* Probabilities are computed using asymptotic Chi-square distribution.

Results for Individual Countries

Ghana

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPS	0.081635	0.021256	3.840665	0.0216
LLR	-0.079260	0.019909	-3.981218	0.0377
MKT	-1.099442	0.168479	-6.525696	0.0227
SMT	0.127506	0.029366	4.341928	0.0492
LGDPPC	-2.112603	0.749079	-2.820268	0.1061
LENC	0.797815	0.613233	1.300999	0.3230
FDI	0.348417	0.083433	4.176001	0.0528
URB	0.335426	0.214385	1.564600	0.2581
SER	0.717160	7.970427	0.089978	0.9365
C	16.86885	4.667019	3.614480	0.0687

EC = LCO2 - (0.0816*CPS -0.0793*LLR -1.0994*MKT + 0.1275*SMT
-2.1126*LGDPPC + 0.7978*LENC + 0.3484*FDI + 0.3354*URB +
0.7172*SER + 16.8688)

ARDL Error Correction Regression
Dependent Variable: D(LCO2)
Selected Model: ARDL(1, 2, 1, 2, 2, 2, 2, 2, 2, 2)
Case 2: Restricted Constant and No Trend
Date: 01/24/24 Time: 06:48
Sample: 1990 2022
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPS)	0.021837	0.001324	16.49908	0.0037
D(CPS(-1))	-0.066714	0.001381	-48.29359	0.0004
D(LLR)	-0.112587	0.002011	-55.97336	0.0003
D(MKT)	-0.538492	0.016504	-32.62868	0.0009
D(MKT(-1))	1.330037	0.024239	54.87259	0.0003
D(SMT)	-0.075677	0.002314	-32.70025	0.0009
D(SMT(-1))	-0.177928	0.003417	-52.07821	0.0004
D(LGDPPC)	0.730942	0.075842	9.637728	0.0106
D(LGDPPC(-1))	-1.469595	0.086959	-16.89977	0.0035
D(LENC)	-0.473926	0.032518	-14.57446	0.0047
D(LENC(-1))	-0.378902	0.027294	-13.88216	0.0051
D(FDI)	0.283460	0.005984	47.37067	0.0004
D(FDI(-1))	-0.096450	0.005140	-18.76541	0.0028
D(URB)	38.79897	0.892728	43.46111	0.0005
D(URB(-1))	-56.37036	1.090573	-51.68875	0.0004
D(SER)	-8.639398	0.856070	-10.09193	0.0097

D(SER(-1))	21.65508	1.092864	19.81498	0.0025
CointEq(-1)*	-1.228240	0.020412	-60.17108	0.0003

R-squared	0.998061	Mean dependent var	0.033316
Adjusted R-squared	0.995314	S.D. dependent var	0.165526
S.E. of regression	0.011331	Akaike info criterion	-5.838844
Sum squared resid	0.001541	Schwarz criterion	-4.998126
Log likelihood	105.5827	Hannan-Quinn criter.	-5.569891
Durbin-Watson stat	2.839678		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	54.85695	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPS	-0.132178	0.062540	-2.113486	0.0389
LLR	0.096518	0.032291	2.989045	0.0261
MKT	0.296602	0.390151	0.760225	0.5265
SMT	-0.207669	0.069371	-2.993585	0.0158
LGDPPC	4.138106	1.707593	2.423357	0.1363
LENC	-0.746555	1.006294	-0.741885	0.5354
FDI	-0.171472	0.046263	-3.706476	0.0057
URB	0.850410	0.275956	3.081691	0.0011
SER	-26.89678	8.223424	-3.270752	0.0021
C	1.048002	6.868238	0.152587	0.8927

EC = LCO2 - (-0.1322*CPS + 0.0965*LLR + 0.2966*MKT -0.2077*SMT +
4.1381*LGDPPC -0.7466*LENC -0.1715*FDI + 0.8504*URB
-26.8968*SER + 1.0480)

ARDL Error Correction Regression
Dependent Variable: D(LCO2)
Selected Model: ARDL(1, 1, 2, 2, 2, 2, 2, 2, 2, 2)
Case 2: Restricted Constant and No Trend
Date: 01/24/24 Time: 06:51
Sample: 1990 2021
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPS)	-0.228666	0.014851	-15.39732	0.0042
D(LLR)	0.061123	0.004701	13.00125	0.0059
D(LLR(-1))	-0.056356	0.004759	-11.84205	0.0071
D(MKT)	0.106976	0.025763	4.152299	0.0534
D(MKT(-1))	-0.296714	0.036250	-8.185211	0.0146
D(SMT)	-0.134018	0.009287	-14.43107	0.0048
D(SMT(-1))	0.142375	0.010731	13.26708	0.0056
D(LGDPPC)	1.231141	0.393249	3.130686	0.0887
D(LGDPPC(-1))	-6.580502	0.684599	-9.612201	0.0107
D(LENC)	-0.066237	0.072319	-0.915903	0.4564
D(LENC(-1))	0.256262	0.070399	3.640163	0.0679
D(FDI)	-0.042204	0.005900	-7.153046	0.0190
D(FDI(-1))	0.199055	0.015427	12.90335	0.0060
D(URB)	10.91046	0.823176	13.25410	0.0056
D(URB(-1))	9.971180	0.850783	11.72000	0.0072
D(SER)	-29.06783	2.169725	-13.39701	0.0055
D(SER(-1))	8.996973	1.323937	6.795619	0.0210
CointEq(-1)*	-1.486457	0.094828	-15.67537	0.0040

R-squared	0.973585	Mean dependent var	0.054067
Adjusted R-squared	0.936165	S.D. dependent var	0.114745
S.E. of regression	0.028991	Akaike info criterion	-3.959950
Sum squared resid	0.010086	Schwarz criterion	-3.119231
Log likelihood	77.39924	Hannan-Quinn criter.	-3.690997
Durbin-Watson stat	2.565495		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.722988	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68

Kenya

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPS	-0.057240	0.008474	-6.754797	0.0212
LLR	0.033812	0.012595	2.684576	0.1153
MKT	-0.202661	0.019096	-10.61267	0.0088
SMT	0.069232	0.007830	8.842076	0.0126
LGDPPC	2.987882	0.908827	3.287624	0.0814
LENC	-3.226662	0.323521	-9.973572	0.0099
FDI	0.080845	0.026236	3.081416	0.0311
URB	2.142526	0.276479	7.749334	0.0162
SER	-15.00265	3.378634	-4.440447	0.0272
C	17.42846	7.810511	2.231411	0.1553

EC = LCO2 - (0.0572*CPS + 0.0338*LLR -0.2027*MKT + 0.0692*SMT +
2.9879*LGDPPC -3.2267*LENC + 0.0808*FDI + 2.1425*URB
-15.0026*SER + 17.4285)

ARDL Error Correction Regression
Dependent Variable: D(LCO2)
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 1, 2, 2, 2)
Case 2: Restricted Constant and No Trend
Date: 01/24/24 Time: 06:55
Sample: 1990 2021
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPS)	-0.054932	0.001282	-42.83535	0.0005
D(CPS(-1))	-0.083995	0.001494	-56.22139	0.0003
D(LLR)	0.038778	0.001114	34.80076	0.0008
D(LLR(-1))	0.049592	0.000854	58.04419	0.0003
D(MKT)	-0.216761	0.003454	-62.75259	0.0003
D(MKT(-1))	0.118426	0.002737	43.26766	0.0005
D(SMT)	0.045640	0.001095	41.67141	0.0006
D(SMT(-1))	-0.032968	0.000958	-34.42011	0.0008
D(LGDPPC)	5.244420	0.086262	60.79609	0.0003
D(LGDPPC(-1))	5.190509	0.102124	50.82538	0.0004
D(LENC)	-1.404336	0.026542	-52.91032	0.0004
D(FDI)	-0.093786	0.002085	-44.98196	0.0005
D(FDI(-1))	-0.117837	0.001818	-64.82446	0.0002
D(URB)	-25.42783	0.529892	-47.98682	0.0004
D(URB(-1))	-49.98082	0.893049	-55.96647	0.0003
D(SER)	3.352987	0.113535	29.53252	0.0011
D(SER(-1))	14.87306	0.244686	60.78429	0.0003

CointEq(-1)*	-1.079788	0.014596	-73.98009	0.0002

R-squared	0.998882	Mean dependent var	0.048001
Adjusted R-squared	0.997298	S.D. dependent var	0.103933
S.E. of regression	0.005402	Akaike info criterion	-7.320255
Sum squared resid	0.000350	Schwarz criterion	-6.479537
Log likelihood	127.8038	Hannan-Quinn criter.	-7.051302
Durbin-Watson stat	2.869369		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	82.92507	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68

Mauritius

ARDL Error Correction Regression
Dependent Variable: D(LCO2)
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2, 2, 2)
Case 2: Restricted Constant and No Trend
Date: 01/24/24 Time: 07:01
Sample: 1990 2021
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPS)	-0.007931	0.000244	-32.53978	0.0196
D(CPS(-1))	0.013697	0.000526	26.01707	0.0245
D(LLR)	-0.011345	0.000394	-28.76201	0.0221
D(LLR(-1))	0.005795	0.000349	16.59484	0.0383
D(MKT)	-0.079652	0.002096	-38.00450	0.0167
D(MKT(-1))	0.026114	0.001569	16.64878	0.0382
D(SMT)	0.031706	0.001125	28.19508	0.0226
D(SMT(-1))	-0.022018	0.000743	-29.63942	0.0215
D(LGDPPC)	-3.309691	0.117997	-28.04890	0.0227
D(LGDPPC(-1))	6.020312	0.206640	29.13434	0.0218
D(LENC)	1.196333	0.029235	40.92130	0.0156
D(LENC(-1))	0.264934	0.015884	16.67943	0.0381
D(FDI)	-0.002147	0.001082	-1.983728	0.2973
D(FDI(-1))	-0.025444	0.001113	-22.85842	0.0278
D(URB)	-12.24785	0.331675	-36.92725	0.0172
D(URB(-1))	10.45294	0.330371	31.63996	0.0201
D(SER)	6.874081	0.572927	11.99817	0.0529
D(SER(-1))	41.99597	1.599168	26.26114	0.0242
CointEq(-1)*	-1.852947	0.050015	-37.04749	0.0172

R-squared	0.997183	Mean dependent var	0.035956
Adjusted R-squared	0.992574	S.D. dependent var	0.049555
S.E. of regression	0.004270	Akaike info criterion	-7.810841
Sum squared resid	0.000201	Schwarz criterion	-6.923416
Log likelihood	136.1626	Hannan-Quinn criter.	-7.526947
Durbin-Watson stat	3.353106		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	11.34311	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68

Namibia

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPS	0.073912	0.021947	3.367764	0.0120
LLR	-0.048467	0.015408	-3.145619	0.0163
MKT	-0.049278	0.257368	-0.191471	0.8536
SMT	0.032698	0.009750	3.353496	0.0122
LGDPPC	-1.151436	0.688594	-1.672155	0.1384
LENC	-0.049749	0.146688	-0.339150	0.7444
FDI	-0.073366	0.029761	-2.465221	0.0431
URB	-0.031758	0.035059	-0.905855	0.3951
SER	4.381323	2.242749	1.953550	0.0917
C	17.09514	7.117842	2.401731	0.0473

EC = LCO2 - (0.0739*CPS -0.0485*LLR -0.0493*MKT + 0.0327*SMT
-1.1514*LGDPPC -0.0497*LENC -0.0734*FDI -0.0318*URB + 4.3813
*SER + 17.0951)

ARDL Error Correction Regression
Dependent Variable: D(LCO2)
Selected Model: ARDL(1, 1, 2, 1, 1, 0, 2, 2, 2, 1)
Case 2: Restricted Constant and No Trend
Date: 01/24/24 Time: 07:04
Sample: 1990 2021
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPS)	0.031868	0.001530	20.82403	0.0000
D(LLR)	-0.060740	0.002549	-23.82505	0.0000
D(LLR(-1))	-0.019001	0.002307	-8.237688	0.0001
D(MKT)	0.199871	0.023518	8.498558	0.0001
D(SMT)	0.012003	0.000666	18.02840	0.0000
D(LENC)	0.050092	0.018856	2.656617	0.0326
D(LENC(-1))	-0.049713	0.019470	-2.553352	0.0379
D(FDI)	-0.025946	0.002341	-11.08315	0.0000
D(FDI(-1))	-0.019526	0.001853	-10.53764	0.0000
D(URB)	-0.444167	0.089730	-4.950021	0.0017
D(URB(-1))	-0.778418	0.083736	-9.296121	0.0000
D(SER)	13.65915	1.006673	13.56861	0.0000
CointEq(-1)*	-0.558193	0.029453	-18.95211	0.0000

R-squared	0.976574	Mean dependent var	0.044541

Adjusted R-squared	0.960038	S.D. dependent var	0.115604
S.E. of regression	0.023110	Akaike info criterion	-4.398428
Sum squared resid	0.009079	Schwarz criterion	-3.791243
Log likelihood	78.97642	Hannan-Quinn criter.	-4.204184
Durbin-Watson stat	2.291875		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	13.44533	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68

Nigeria

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPS	-0.018998	0.006931	-2.743994	0.0203
LLR	0.003548	0.006957	0.509972	0.6170
MKT	-0.042161	0.019973	-2.135257	0.0451
SMT	0.009591	0.005568	1.722453	0.1043
LGDPPC	-0.610825	0.267975	-2.279411	0.0367
LENC	1.030215	0.240003	4.292501	0.0006
FDI	0.006496	0.018843	0.344761	0.7348
URB	-0.035410	0.052476	-0.674789	0.5094
SER	1.775887	1.570502	1.130776	0.2748
C	16.09444	1.498259	10.74210	0.0000

EC = LCO2 - (-0.0190*CPS + 0.0035*LLR -0.0422*MKT + 0.0096*SMT
-0.6108*LGDPPC + 1.0302*LENC + 0.0065*FDI -0.0354*URB +
1.7759*SER + 16.0944)

ARDL Error Correction Regression
Dependent Variable: D(LCO2)
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2, 2, 1)
Case 2: Restricted Constant and No Trend
Date: 01/24/24 Time: 07:06
Sample: 1990 2021
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPS)	0.091765	0.005818	15.77309	0.0040
D(CPS(-1))	-0.027821	0.004438	-6.268052	0.0245
D(LLR)	-0.003762	0.003612	-1.041511	0.4070
D(LLR(-1))	0.044150	0.004781	9.233811	0.0115
D(MKT)	0.044609	0.015966	2.794031	0.1078
D(MKT(-1))	1.143560	0.074373	15.37608	0.0042
D(SMT)	-0.070128	0.007677	-9.134601	0.0118
D(SMT(-1))	-0.122850	0.007099	-17.30572	0.0033
D(LGDPPC)	14.59617	0.882347	16.54244	0.0036
D(LGDPPC(-1))	7.021345	0.494821	14.18967	0.0049
D(LENC)	-0.092112	0.113158	-0.814009	0.5011
D(LENC(-1))	-1.956310	0.157122	-12.45088	0.0064
D(FDI)	0.040396	0.006127	6.593511	0.0222
D(FDI(-1))	-0.066723	0.006431	-10.37523	0.0092
D(URB)	-9.922483	0.525058	-18.89787	0.0028

D(URB(-1))	-7.365970	0.448325	-16.42999	0.0037
D(SER)	11.74564	1.094202	10.73444	0.0086
CointEq(-1)*	-0.484351	0.026344	-18.38574	0.0029

R-squared	0.988060	Mean dependent var	0.039463
Adjusted R-squared	0.971145	S.D. dependent var	0.176741
S.E. of regression	0.030023	Akaike info criterion	-3.890010
Sum squared resid	0.010816	Schwarz criterion	-3.049292
Log likelihood	76.35016	Hannan-Quinn criter.	-3.621057
Durbin-Watson stat	2.478806		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.121749	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68

Levels Equation
Case 4: Unrestricted Constant and Restricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPS	0.000558	0.001528	0.365380	0.7189
LLR	-0.005122	0.002558	2.038473	0.0458
MKT	-0.000234	0.001108	-0.211382	0.8348
SMT	-1.81E-05	0.002687	-0.006752	0.9947
LGDPPC	-1.563287	1.121068	-1.394462	0.1793
LENC	1.718794	0.763514	2.251162	0.0364
FDI	0.009606	0.008674	1.107485	0.2819
URB	0.561668	0.398141	1.410726	0.1745
SER	-0.071032	0.121211	-0.586022	0.5648
@TREND	-0.251569	0.189398	-1.328256	0.1998

EC = LCO2 - (0.0006*CPS + 0.0051*LLR -0.0002*MKT -0.0000*SMT
-1.5633*LGDPPC + 1.7188*LENC + 0.0096*FDI + 0.5617*URB
-0.0710*SER -0.2516*@TREND)

ARDL Error Correction Regression
Dependent Variable: D(LCO2)
Selected Model: ARDL(1, 2, 2, 2, 2, 2, 2, 2, 2, 2)
Case 2: Restricted Constant and No Trend
Date: 01/24/24 Time: 07:12
Sample: 1990 2021
Included observations: 30

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPS)	-0.001488	0.000912	-1.631710	0.3500
D(CPS(-1))	-0.025672	0.001989	-12.90609	0.0492
D(LLR)	-0.043504	0.003876	-11.22313	0.0566
D(LLR(-1))	0.026264	0.003020	8.695883	0.0729
D(MKT)	-0.002564	0.000433	-5.917796	0.1066
D(MKT(-1))	-0.005580	0.000509	-10.96143	0.0579
D(SMT)	0.012411	0.001334	9.304010	0.0682
D(SMT(-1))	-0.002813	0.001142	-2.463660	0.2455
D(LGDPPC)	1.615232	0.466794	3.460269	0.1791
D(LGDPPC(-1))	-10.42110	0.927196	-11.23937	0.0565
D(LENC)	12.61631	0.982023	12.84727	0.0495
D(LENC(-1))	-1.519856	0.292617	-5.194011	0.1211
D(FDI)	-0.002436	0.004118	-0.591688	0.6599
D(FDI(-1))	0.064602	0.006340	10.18928	0.0623
D(URB)	-1.336844	0.671055	-1.992152	0.2962
D(URB(-1))	20.43205	1.765574	11.57247	0.0549
D(SER)	1.877904	0.150894	12.44516	0.0510
D(SER(-1))	-21.03121	1.689587	-12.44754	0.0510
CointEq(-1)*	-0.502835	0.040466	-12.42619	0.0511

R-squared	0.962251	Mean dependent var	0.009683
Adjusted R-squared	0.900479	S.D. dependent var	0.053244
S.E. of regression	0.016797	Akaike info criterion	-5.071894
Sum squared resid	0.003103	Schwarz criterion	-4.184469
Log likelihood	95.07841	Hannan-Quinn criter.	-4.787999
Durbin-Watson stat	2.966847		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	2.116116	10%	1.8	2.8
k	9	5%	2.04	2.08
		2.5%	2.24	3.35
		1%	2.5	3.68