Africa Studies Effects of Environmental Factors on Economic Development

Edited by

Abdulkadri Toyin Alabi
Ahmet Kardaşlar

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Authors

Abdulkadri Toyin Alabi

A. I. Shuaeeb,

Danstan Aguta

Derrick Mbalule

Ibrahim Mukisa

Justine Luwedde

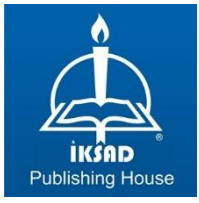
Mustafa Latif Emek

Philemon Okillong

R. M. Bello (PhD)

Saheed Olanrewaju Issa

Winnie Nabiddo



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TURKEY TR: +90 342 606 06 75
USA: +1 631 685 0 853
E mail: iksadyayinevi@gmail.com
www.iksadyayinevi.com

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PREFACE

In an age where our world faces complex and pressing challenges, the interplay between economics, the environment, and sustainable development has emerged as a central focus of global discourse. Within the pages of this book, you will embark on a journey through four thought-provoking chapters that delve deep into the intricate relationships between environmental accounting, eco-literacy, industrialization, clean energy use, and their profound impacts on economic development.

Chapter 1, "Environmental Accounting as a Tool for Economic Development: A Case Study of Listed Companies in Nigeria," takes us to the vibrant heart of West Africa. This chapter unravels the profound significance of environmental accounting in the context of economic development, offering valuable insights into the strategies and practices of listed companies in Nigeria. It emphasizes the need for businesses to embrace environmentally responsible practices, not only for the well-being of the planet but also for their long-term economic sustainability.

Chapter 2, "Eco-Literacy and Economic Development in Nigeria: A Symbiotic Relationship," carries us into the realm of eco-literacy, a concept that underscores the vital connection between environmental knowledge and the economic progress of a nation. Through a comprehensive exploration of Nigeria's eco-literacy landscape, this chapter highlights how a well-informed populace can catalyze sustainable development and create a symbiotic relationship between the environment and the economy.

As we journey into Chapter 3, we shift our focus to Uganda, where "The Effects of Industrialization and Financial Development on Carbon Emissions in Uganda" unfolds. This chapter examines the intricate dynamics between industrialization, financial development, and their impact on carbon emissions. By doing so, it provides an essential perspective on the environmental consequences of economic growth in a developing nation, ultimately shedding light on the path towards greener and more sustainable industrialization.

Lastly, Chapter 4, "Clean Energy Use and Sustainable Development Paradox: The Case of Clean Cooking Solutions in Uganda," invites us to explore the often-overlooked domain of clean energy and its paradoxical relationship with sustainable development. Through the lens of clean cooking solutions, this chapter reveals the challenges and opportunities inherent in the pursuit of clean energy alternatives and how they can contribute to Uganda's broader development goals.

The chapters contained in this book represent a collective effort by experts and scholars who have invested their time, knowledge, and passion to unravel the intricate web of relationships between our environment and economic development. Their rigorous research, insightful analysis, and innovative solutions provide us with a unique opportunity to better understand the complexities of these issues and the potential for positive change.

We hope that the knowledge contained within these pages serves as a catalyst for discussions, decisions, and actions that lead to a more sustainable and prosperous future. As we embark on this intellectual journey, may we all become more conscious stewards of our environment, more informed leaders in economic development, and more responsible global citizens.

With great anticipation, we invite you to delve into these pages, explore the insights presented, and join us in the quest for a harmonious coexistence between our economic aspirations and the preservation of our planet.

Editors

CHAPTER 1

ENVIRONMENTAL ACCOUNTING AS A TOOL FOR ECONOMIC DEVELOPMENT. A CASE STUDY OF LISTED COMPANIES IN NIGERIA

Abdulkadri Toyin Alabi[1]

Saheed Olanrewaju Issa[2]

Mustafa Latif Emek [3]

[1] Kwara State University, Malete, Nigeria
E-mail: alabiabdulkadri@gmail.com
[2] Kwara State University, Malete, Nigeria
E-mail: issasaheed22@gmail.com
[3] (ORCID: 0000-0002-7079-9781)
IKSAD – Institute of Economic Development and Social Researche

1.0 INTRODUCTION

It is worth noting that environmental problems have repercussions not only on the human and natural environments but also on the global economy (Amiri et al., 2014). The significance of environmental resources such as water, air, soil, and forests underscores the necessity for their explicit consideration at both macro- and micro-planning levels (Herath, 2005). Effective macroeconomic planning requires a recognition of the importance of the natural environment, as incorporating it into national accounts offers vital information about how natural resources are utilized in economic activities (Jones, 1996). Environmental accounting rectifies national income accounts by presenting a balance sheet of natural resources, recording their quantity and value (Herath, 2005). This information proves invaluable for policymakers and resource managers, assisting in assessing the rate of depletion of natural resources within an economy and formulating policies to mitigate resource degradation. The incorporation of monetary values of these resources into national income offers a reliable gauge of economic performance, facilitating the formulation of sound macroeconomic policies with the availability of explicit information.

From a microeconomic viewpoint, it is evident that commercial organisations frequently offer restricted stakeholder groups with limited information by omitting details about their utilization of environmental assets (Pearce & Turner, 1990). However, contemporary conceptions of legitimacy necessitate the dissemination of information to a broader societal audience. To meet these broader objectives, business firms should go beyond mere disclosure and integrate their activities and their impact on the environment into their reporting. In essence, it is important for businesses to internalize the external costs and benefits of their activities. Resource allocation can be enhanced by implementing a comprehensive reporting approach that encompasses all aspects of the business. Companies that aim to showcase their dedication to environmentally sustainable development need to connect the domains of environmental management, finance, and economics. Environmental

accounting plays a crucial role in this integration by examining the financial consequences of environmental impact and organizational factors, such as their influence on cash flow and revenue (Hernádi & Bettin, 2012). It enables the translation of environmental impact and concerns into monetary values (Herath, 2005).

Countries and corporate entities, especially those involved in heavy industrial production, engages in a variety of activities that have detrimental environmental repercussions, in the quest of economic growth. Regardless of the type of business or sector, the creation of tangible goods frequently leads to waste generation and the depletion of natural resources. Different industries exhibit various environmental footprints, such as oil spills by oil and gas companies, deforestation of rainforests by timber manufacturers, and pollution of air, land, and water by manufacturing firms, among others. The increased use of chemicals, including agricultural pesticides and herbicides, has led to biodiversity loss and the inefficient use of materials without recycling (Ayres, 2004). Environmental implications of industrial activities are frequently disregarded, particularly in emerging nations such as Nigeria. These environmental issues become more apparent and severe with time, making apathy untenable. These environmental problems exact a direct toll on the economy through violent demonstrations by local community members and indirectly through inefficient production processes leading to the depletion of natural resources (Okafor, 2018).

The escalating global environmental challenges have raised awareness regarding various environmental issues and dilemmas. There exists a multitude of environmental problems, encompassing issues such as climate change, ozone layer depletion, air and water pollution, desertification, habitat loss, and numerous others, all of which pose significant threats to humanity (Dutta & Bose, 2012). These challenges are closely intertwined with the operating operations of corporate entities. Similar to how humans leave footprints in the sand as a marker of their presence, entities also leave discernible imprints on the environment, referred to as environmental footprints. Industries wield substantial influence over the environment, whether through the

generation of industrial waste and pollution or the depletion of natural resources (Xiaoping, 2003).

In contemporary business practices, corporations are increasingly expected to assume responsibility not only for their financial objectives but also for addressing environmental and sustainability concerns, given their substantial reliance on ecosystems (Alabi, 2022). International organizations have consistently voiced environmental apprehensions and proposed global corrective measures (Salama et al., 2012). Assigning accountability to firms for their environmental impact has been one such strategy to mitigate environmental harm. These discussions have ignited concerns among various stakeholders, including host communities, government and its agencies, employees, and customers, regarding the adverse effects of corporate operations (Abiola & Ashamu, 2012). Consequently, corporations have faced criticism for their perceived contribution to social problems (Hackston & Milne, 1996), particularly exemplified in the Nigerian context by resource depletion in the Niger Delta region (Donwa, 2011).

Environmental accounting serves as a societal mechanism for corporate entities to account for the environmental implications of their operating activities. According to Cornnor (2006), environmental accounting is described as an accounting practice that encompasses the collection, recording, and reporting of both financial and non-financial information related to the effect of firms operating activities on people, communities, and the natural environment. According to Smith (2003), environmental accounting aligns with businesses and practices deemed environmentally responsible, involving the use of organic and natural materials, stringent emission controls, and eco-friendly sourcing of materials. As emphasized by Ironkwe and Success (2017), the prominence of environmental accounting escalated due to global concerns about climate change.

The discourse surrounding environmental accounting and its economic impact spans both developed and developing nations,

sparking extensive scholarly debate and literature. It might be assumed that research on environmental accounting has reached saturation; however, it remains a dynamic and evolving field. Environmental accounting provides a regulatory framework to curb environmentally unsustainable corporate activities, prompting organizations to adopt environmentally friendly production methods beneficial not only to their bottom line but also to the nation's economic well-being (Amiri et al., 2014; Alabi & Issa, 2022).

In Nigeria, business organizations often shy away from environmental accounting practices due to perceived prohibitive costs. Additionally, lax regulation creates loopholes in environmental laws that firms exploit to evade their societal responsibilities, leading to pollution and health issues in local communities (Beredugo & Mefor, 2012). Consequently, society demands that firms account for the environmental consequences of their economic activities. While various perspectives exist on environmental accounting, Bartolomeo et al. (2000) view it as a superset of accounting, while Okafor (2018) describes it as the integration of the environmental dimension at the macro or micro level.

Empirical and theoretical studies on environmental accounting have proliferated, conducted by scholars such as Salama et al. (2012), Hernádi & Bettini (2012), Kilian & Hennings (2014), and Kumar (2017), exploring the environmental accounting practices of corporations across different global economies, with a predominance in developed nations. These findings may differ from those in developing countries like Nigeria due to differences in legal and regulatory frameworks. In the context of developing countries, studies by Okafor (2018), Beredugo & Mefor (2012), Alabi & Issa (2022), Okoye & Ezejiofor (2013), and Ironkwe & Success (2017) have examined environmental accounting from the perspective of sustainability and economic development, yet have not reached a consensus on the intrinsic relationship between environmental accounting and economic development. They have also often concentrated on specific sectors

within developing economies, which may not fully represent the entire economic landscape.

Considering the significant environmental challenges faced by Nigeria, numerous empirical studies have investigated the sources of these problems and proposed solutions. However, previous research primarily focused on the impact of environmental accounting on individual organizations. This study, in contrast, explores the broader impact of environmental accounting practices on economic development in Nigeria, addressing a novel aspect of the literature. Therefore, this study seeks to fill gaps in previous research by examining the distinct links between environmental accounting (specifically, environmental costs) and Nigerian economic development, shedding light on this contentious facet of accounting. To this end, the study addresses the following pivotal question: What role does environmental accounting play in fostering the economic development of Nigeria?

The remainder of this paper is structured as follows: Section 2 discusses the concepts, previous empirical evidence on environmental accounting and economic development, and presents the theoretical framework underpinning this study. Section 3 outlines the methodology, while Section 4 presents the study's findings. Finally, Section 5 concludes the report with recommendations.

2. Literature Review

2.1.1 Concept of Environmental Accounting

Environmental Accounting encompasses both national and corporate-level evaluations of environmental performance, integrating both financial and non-financial data (Beer & Friend, 2019). Osemene (2010) emphasizes that environmental accounting provides critical insights into the utilization of natural resources, the communication of business activity costs, and their potential environmental impacts, both at the corporate and national levels. Howes (2002) posits that environmental accounting connects various facets of accounting,

encompassing external and internal environmental accounting, while also aligning organizational culture with environmental sustainability, creating a more comprehensive perspective. The initiative of environmental accounting serves to identify and raise awareness about environmental costs and methods for cost reduction and avoidance (Farouk et al., 2012). Environmental accounting, as a subset of accounting, encompasses activities, methods, systems, as well as the recording, analysis, and reporting of financially and ecologically influenced impacts (Burritt et al., 2002). This includes monetary data encompassing material costs of products and non-product outputs, expenses related to waste and emission control, prevention measures, environmental management, and research and development costs (Sumiani et al., 2007).

At the core of environmental accounting lie environmental costs, a concept formally introduced by the Environmental Protection Agency in the mid-1990s (1995). These costs encompass expenses that directly affect organizational, financial, and economic performance, extending to societal, community, environmental, and individual impacts not attributed to the company. Environmental costs can be categorized into two main groups (The Environmental Protection Agency, 1995). The first group includes internal environmental costs, which encompass conventional expenses associated with materials, equipment, and supplies. It also includes hidden environmental costs that emerge from allocation of environmental expense to overhead cost pools. In addition, it includes contingent costs, which are uncertain and dependent on unforeseen circumstances, and image costs associated with the organization's reputation (Beer et al., 2005; Gale & Stokoe, 2001). The second group comprises external environmental costs, covering environmental degradation for which organizations bear no legal responsibility and adverse effects on individuals, the organization's assets, and benefits that may not be compensated for by legal systems (Environmental Protection Agency, 1995).

In summary, the Environmental Protection Agency (1995) defines environmental accounting as the identification and

quantification of environmental costs associated with materials and activities, with the aim of informing environmental management decisions that benefit shareholders. However, Al-Mawali (2021) suggests that environmental accounting involves incorporating environmental and social considerations into existing financial information to meet stakeholder expectations.

2.1.2. Environmental Accounting and Economic Development

Much like how the environmental actions of corporations impact the economy, the practice of accounting for these environmental actions also wields a significant influence on economic outcomes. Environmental accounting serves as a strategic tool enabling firms to anticipate the future consequences of their environmental practices. When such assessments indicate favorable outcomes, companies are incentivized to embrace environmentally responsible measures (Araoye et al., 2018). Consequently, when a firm undertakes remediation efforts to rectify the environmental damage it has caused, this can result in the creation of employment opportunities and the redistribution of a portion of the company's earnings within the local community (Alabi, 2022). Additionally, these remediation activities may restore resources like farmlands and bodies of water for fishing to a state close to their original condition, thereby rendering them productive once more.

The expenses incurred in the course of environmental accounting procedures have the potential to enhance the well-being of local communities. This can be achieved by improving air and water quality, leading to reduced healthcare-related expenditures (Temple & Ogbonna, 2019). In addition, firms that adopt eco-friendly production processes are likely to experience reduced production and related cost, decreased expenses related to environmental litigation, lesser fines imposed by regulatory authorities, increased goodwill from stakeholders, more patronage from environmentally conscious consumers, and ultimately higher income and profits. Given that a flourishing business sector contributes to overall economic prosperity,

it becomes evident that the practices of environmental accounting exert a tangible impact on the broader economy (Al-Mawali, 2021).

However, it is important to acknowledge that while environmental accounting holds promise as a means of advancing sustainable economic development, it is not without its challenges. These challenges encompass the intricacies of data collection, the imperative for standardized reporting frameworks, and the risk of "greenwashing" – the dissemination of misleading or exaggerated environmental information. Effectively addressing these challenges necessitates collaborative efforts among governments, businesses, and regulatory bodies (Eze et al., 2016).

2.2 Empirical Review

Al-Mawali (2021) conducted an investigation into the direct and indirect relationships among environmental cost accounting, environmental performance, and financial performance. The study focused on firms quoted in the industrial sector of the Amman Stock Exchange. Subjective data was collected through questionnaires to measure environmental cost accounting and financial performance, while objective data were extracted from annual reports to assess financial performance. Structural equation modeling was employed for data analysis. The findings indicated that environmental cost accounting positively influenced both environmental performance and financial performance. Additionally, the study confirmed the mediating role of environmental performance in the direct relationship between environmental cost accounting and financial performance.

In a separate study, Enerson and AdegbieFolajimi (2021) examined the association between environmental accounting practices and the capacity for environmental sustainability in the context of a sustainable economy. The research adopted an ex-post facto research design, focusing on the entire manufacturing industry with a purposive sample of five firms. The findings demonstrated a significant and positive relationship between the variables under investigation. Specifically, economic sustainability and the extent of economic

disclosures were found to have significant and positive effects on performance.

In their study, Temple and Ogbonna (2019) examined the influence of environmental accounting on Nigeria's economic development. They used content analysis on data gathered from secondary sources. The compliance levels and expenses related to accounting for environmental impacts were evaluated using data from the annual reports of five manufacturing firms. Data analysis was done using multiple regression. Result of the study indicated that environmental protection costs, environmental management costs, and environmental research and development costs had a considerable impact on Nigeria's GDP. However, these effects were not statistically significant, implying that the enumerated environmental accounting elements did not significantly impact economic development in Nigeria.

Araoye et al. (2018) conducted a study on the impact of environmental pollution on economic growth in Nigeria. Data gathered from secondary sources was analysed using the ordinary least squares approach. Findings shows that that pollution have no significant impact on economic growth. The study suggested the implementation of stricter charges and penalties for oil spillage and gas flaring to deter companies from engaging in such environmental pollution. In contrast, In their study, Beredugo and Mefor (2012) investigated the impact of environmental accounting and reporting on sustainable development in Nigeria. Through statistical analysis utilizing the Pearson correlation coefficient and ordinary least squares (OLS) method, they discovered that environmental accounting and reporting significantly influences sustainable development. The findings indicated that environmental accounting encouraged firms to acconts for their greenhouse gas emissions and other environmental metrics to meet their reduction targets. The result also found a negative effect of non-compliance with environmental accounting and reporting regulations.

In their study, Eze et al. (2016) investigated the effect of environmental accounting in the context of a developing nation. Their findings indicated that environmental accounting could be effectively used to monitor and measure organizations' environmental performance in a more quantifiable manner. The study also highlighted that multinational oil companies and other extractive firms were not adequately addressing environmental issues affecting oil producing communities in Nigeria, leading to unfavorable relationships among the concerned stakeholders. Furthermore, accounting for environmental costs was identified as a means to support organizational development and increase revenue. In their study, Okoye and Ezejiofor (2013) examined the role of sustainable environmental accounting in improving corporate performance and promoting economic growth in Nigeria. Through their analysis, which employed the Pearson Product Moment Correlation Coefficient, they found a significant relationship between sustainable environmental accounting and corporate productivity.

Kumar (2017) explored the connection between environmental accounting and the triple bottom line, quantitative environmental reporting, standard methods, voluntary environmental disclosure, company size, volume of environmental disclosure, material flow analysis, and life cycle assessment in the context of Bangladeshi companies. The findings indicated that corporate sustainability was associated with economic, social, and environmental performance. Other factors, such as quantitative environmental reporting, standard methods, voluntary environmental disclosure, legal requirements, company size, volume of environmental disclosure, material flow analysis, and life cycle assessment, were found to complement economic, social, and environmental performance in achieving sustainable development in Bangladeshi corporations.

Ironkwe and Success (2017) investigated the relationship beytween environmental accounting and sustainable development. The study focused on the Niger Delta region of Nigeria. Their study utilized Spearman's rank correlation and chi-square analysis. The result

revealed a bidirectional relationship between economic stability, sustainable development, and environmental accounting. The researchers concluded that environmental accounting played a crucial role in achieving sustainable development in Nigeria, especially for companies operating within the Niger Delta region. Jones (2010) developed a multi-layered theoretical model to provide a foundation for environmental accounting and reporting. This model encompassed various elements, including severe environmental threats, corporate responsibility, a new relationship between industry and the environment, measurement of industry's impact, and disclosure and reporting of impacts to stakeholders. The model underscored the need for managers and accountants to address environmental threats promptly, as conventional accounting practices did not provide a comprehensive view of an entity's activities and their environmental effects. It also called for the exploration of potential alternative monetary and non-monetary valuation systems.

In summary, the reviewed academic literature on environmental accounting and economic development primarily focuses on studies conducted in industrialized nations. There is a dearth of research on developing nations and emerging markets, despite anecdotal evidence suggesting the dissipative nature of wasteful energy in such contexts.

2.3 Theoretical Framework

2.3.1 Stakeholder Theory

A substantial body of both empirical research and anecdotal evidence has consistently affirmed the relevance of stakeholder theory in analyzing the relationship between environmental accounting and economic development. This provides solid substantiation that the concept of stakeholder theory is inherently intertwined with the realm of corporate entities. Additionally, this consensus aligns with the perspectives expressed by various scholarly discussions on this subject. To establish a solid foundation for our study and the ensuing discourse on this crucial matter, we will elucidate key positions and contentions

advocated by prominent authorities and renowned scholars in the field of green accounting.

The inception of stakeholder theory can be attributed to Freeman (1984), who laid its foundational principles. This theory posits that companies are integral components of a broader social system and places paramount emphasis on the diverse groups of stakeholders drawn from society. Extensive theoretical and empirical investigations have not only validated the applicability of stakeholder theory but have also underscored its significance in comprehending the intricate relationships between corporations and their staffs, customers, vendors, lenders, societies, government, political groups, and trade unions. These stakeholders exert considerable influence on companies, reinforcing the theory's relevance in the context of corporate research (Donaldson & Preston, 1995).

Nevertheless, it is worth noting that dissenting viewpoints have emerged in response to stakeholder theory. This dissent stems from the existence of conflicting academic literature and opposing stances. Sternberg (1997) disproves the notion that firms can be held collectively accountable to a multitude of stakeholders. Instead, he posits that the primary responsibility of managerial figures lies in achieving a harmonious equilibrium amidst the discordant interests of numerous stakeholders. This challenge arises from the sheer magnitude of stakeholders and the divergent nature of their concerns. In light of stakeholder theory's precedence and its centrality in studies pertaining to environmental accounting and economic development, our research will be firmly anchored in this theoretical framework. This approach is informed by the theory's well-established relevance and its foundational role in shaping discussions surrounding the interplay between environmental accounting and economic advancement.

2.3.2 Political Economy Theory

Gray et al. (1996) define "political economy" as the encompassing framework that governs the social, political, and economic dimensions of human existence. In the realm of accounting

literature, this concept has been employed to elucidate corporate practices related to social and environmental disclosures within a broader sociopolitical context (Deegan & Unerman, 2006). Guthrie and Parker (1990) perceive accounting reports as tools utilized to construct, perpetuate, and legitimize political and economic arrangements in a manner that serves the interests of the organization. In essence, corporate disclosures possess the capability to convey not only economic performance but also social and political performance, thereby aligning the reports with the expectations of multiple stakeholders (AbuRaya, 2012). According to the political economy theory, corporate environmental disclosure serves as a proactive mechanism or strategy implemented by management to mediate, obscure, and mitigate potential social conflicts.

It is essential to recognize that the political economy theory extends beyond a narrow focus on firms' self-interest and wealth maximization. Instead, it takes into account the broader political, social, and institutional context within which organizations operate (Gray et al., 1995). Central to this theory are notions of power conflict, power disparities, and the role of government in shaping the societal structure, which, in turn, influences various aspects of corporate activities (Cooper & Sherer, 1984). Belkaoui (1985) contends that the political environment indirectly impacts the development of accounting practices through government influences and national culture.

2.3.3 Contingency Theory

Contingency theory has emerged as a prevalent framework employed to establish a theoretical foundation for understanding the connection between contextual factors and the procedures associated with management accounting techniques. Moreover, it serves as a framework for examining the association between the utilization levels of management accounting techniques and an organization's overall performance, as evidenced in numerous studies (Chenhall, 2003; Otley, 2016).

In particular, contingency theory has been applied extensively to scrutinize the impact of costing techniques utilization on organizational performance, as indicated in several research endeavors (Henri et al., 2016). Guided by the fundamental premise of contingency theory, which posits that there is no one-size-fits-all costing system suitable for all organizational contexts, it is postulated that organizations must tailor their costing systems to harmonize with the surrounding business environment variables to improve their economic performance. Consequently, given that contemporary businesses contend with frequent fluctuations in environmental costs, both in terms of their magnitude and components, it becomes imperative for these organizations to adapt their costing systems. This adaptation serves the purpose of furnishing management with more precise data pertaining to environmental costs. Such data, in turn, aids management in making informed decisions concerning pricing strategies, objectives, performance assessment criteria, and the incorporation of feedback mechanisms (Ittner et al., 2002).

Therefore, the tenets of contingency theory furnish an apt foundational framework for elucidating the interplay between the variables under scrutiny in the present study. The proposed theoretical framework is visually depicted in Figure 1.0.

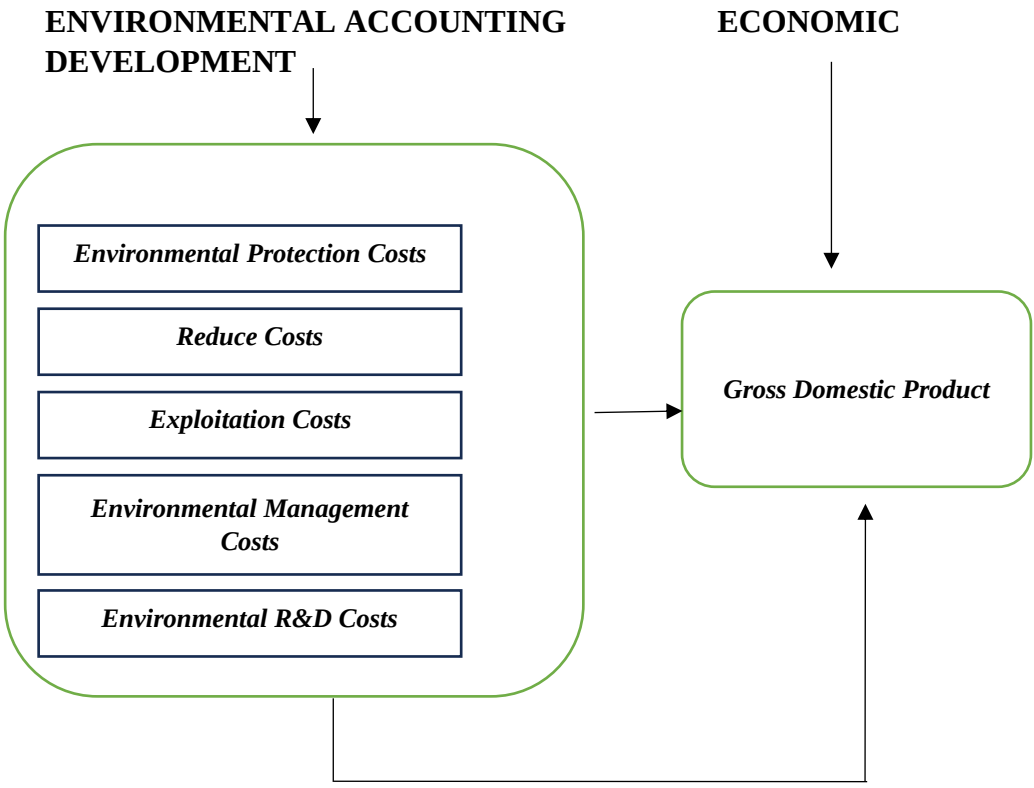

Figure 1.0 Theoretical framework
Source: Authors' conceptualization 2023

Drawing from the literature review and the theoretical framework discussed above, this research paper formulates the following hypotheses that investigate the relationship between environmental accounting and economic development, posited in their null form:

H_{01}: There is no significant relationship between environmental protection costs and the Nigerian economy.
H_{02}: Reduce costs do not significantly affect the performance of the Nigerian economy.
H_{03}: Exploitation costs do not significantly affect the Nigerian economy
H_{04}: There is no significant relationship between environmental management costs and the Nigerian economy

H_{05}: Environmental research and development costs do not significantly affect the Nigerian economy.

3.0 Methodology

The research employs an ex-post facto research design, as the primary objective of the study is to investigate the impact of environmental accounting on the economic development of Nigeria, focusing on the publicly quoted companies in the country. The population under consideration for sample selection consists of all the listed companies, as depicted in Figure 2.0 below, on the Nigerian Exchange Group (NGX Group) as of September 4th, 2023. This population comprises a total of 154 companies, spanning the period from 2012 to 2021.

The selection of the sample was contingent upon the availability of annual reports. After excluding companies with missing annual reports, the final sample consisted of 400 firm-year observations. It is noteworthy that the annual report serves as the primary source of environmental information (Deegan & Rankin, 1997; Tilt, 1994) and is the basis for our data collection. The annual report is considered a reliable source of environmental data since it is prepared under the guidance of accountants (Guthrie & Parker, 1989). Additionally, it enjoys wide accessibility among all stakeholders and is dependable due to its provision of consistent measurements.

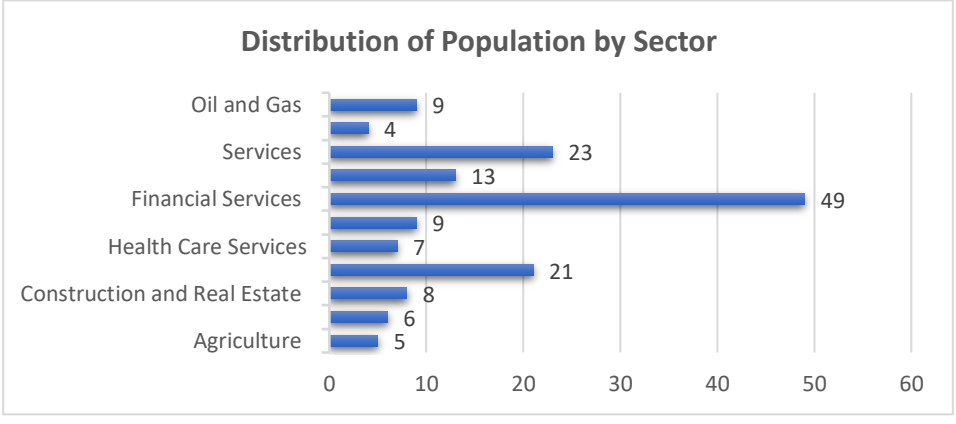

Figure 2.0 Distribution of the Population by Sector

Data acquisition involved the utilization of content analysis techniques, focusing on the examination of environmental accounting elements within the annual reports of the selected companies. This examination was conducted in alignment with the Environmental Accounting Disclosure Index (EADI), which is outlined in Table 3.1 below.

Table 3.1 Environmental Accounting Disclosure

	Environmental accounting disclosure items	**Yes**	**No**
S/N	***Item; Environmental protection costs***	1	0
1	Pollution control costs	1	0
2	Expenses on Environmentally Friendly Equipment	1	0
3	Pollution Control Systems and Policies	1	0
4	Employee Training on Environmental Protection	1	0
S/N	***Item; Reduce Costs***		
1	Environmental Planning Costs	1	0
2	Process Control Costs	1	0
3	Emissions Measurement Equipment Costs	1	0
4	Harmless Product Design Costs	1	0
5	Recycling Operating Costs	1	0
6	Harmless Packaging Design Costs	1	0
7	Environmental Development Costs	1	0
8	Environmental Education Costs	1	0
9	Laboratory Services Costs	1	0
10	Environmental Engineering Services Costs	1	0
11	Environmental Reporting Costs	1	0
12	Environmental Labeling Costs	1	0
13	Environment Reliability Costs	1	0
14	Environmental Information System Costs	1	0
15	Environmental Management System Costs	1	0
16	Environmental Audit Costs	1	0
17	Environmental Handbook Costs	1	0
18	Product Liability Insurance Costs	1	0
19	Waste Control Costs	1	0
20	Waste Disposal Costs	1	0
21	Waste Treatment Costs	1	0
22	Research and Development Costs	1	0

23	Other Reduce Costs	1	0
S/N	***Item; Exploitation Costs***		
1	Air Costs	1	0
2	Water Costs	1	0
3	Soil Costs	1	0
4	Noise Costs	1	0
5	Image Costs	1	0
6	Gas Costs	1	0
7	Oil Costs	1	0
8	Coal Costs	1	0
9	Other Energy Costs	1	0
10	Other Exploitation Costs	1	0
S/N	***Item; Environmental management costs***		
1	Employee Training on the Environmental Management	1	0
2	Environmental Pollution Remediation	1	0
3	Adherence to Environmental Best Practices	1	0
4	Environmental Programmes and policies	1	0
S/N	***Item; Environmental R&D costs***		
1	Research and Development Expense	1	0
2	University Research Sponsorship	1	0
3	Active R&D Environmental Laboratory	1	0
4	New Product Research Initiatives	1	0

Source: Environmental Accounting Disclosure Index (EADI)

The items within the disclosure index were assessed in relation to the Gross Domestic Product (GDP), a key metric for gauging economic performance. To scrutinize the data, we employed the multiple regression analysis methodology. Based on the information presented above, we can assert the following:

Economic Development = f(Environmental Accounting) (1)

Economic development is proxied as Gross Domestic Product (GDP), and Environmental Accounting is proxied as EPC, RC, EC, EMC and ERD. The below equation is hence restated in its natural form:

$$GDP = f(EPC, RC, EC\ EMC, ERD) \quad (2)$$

$$GDP = \beta 0 + \beta 1 EPC_{it} + \beta 2 RC_{it} + \beta 3 EC_{it} + \beta 4 EMC_{it} + \beta 5 ERD_{it} + \varepsilon_{it}. \quad (3)$$

Where;

GDP = Gross Domestic Product
EPC = Environmental Protection Costs
RC = Reduce Costs
EC = Exploitation Costs
EMC = Environmental Management Costs
ERD= Environmental Research and Development Costs
β1, and β2 = coefficients of the variables to be estimated
β0: intercept
ε_{it}: random error term

4.0 Findings of the Study

These descriptive statistics (See Table 4.1) provide an initial understanding of the data's central tendency, variability, and distribution shape.

Table 4.1 Descriptive Statistics

Variables	Mean	Standard Deviation	Kurtosis	Skewness	Minimum	Maximum	Count
GDP	460.10	55.51	-0.38	0.52	375.75	574.18	400
EPC	0.51	0.50	-2.01	-0.02	0.00	1.00	400
RC	0.53	0.50	-2.00	-0.11	0.00	1.00	400
EC	0.48	0.50	-2.00	0.08	0.00	1.00	400
EMC	0.55	0.50	-1.98	-0.18	0.00	1.00	400
ERD	0.50	0.50	-2.01	0.02	0.00	1.00	400

Source: Author's Computation (2023)

Based on table 4.1 above, the mean which represents the average value of each variable shows that GDP has a mean of 460.10, indicating that, on average, the GDP is around 460.10. EPC has a mean of 0.51, suggesting that, on average, the Environmental Protection Costs are 0.51. RC has a mean of 0.53, meaning that, on average, Reduce Costs are 0.53. EC has a mean of 0.48, indicating that, on average, Exploitation Costs are 0.48. EMC has a mean of 0.55,

implying that, on average, Environmental Management Costs are 0.55. ERD has a mean of 0.50, suggesting that, on average, Environmental Research and Development Costs are 0.50. With respect to the standard deviation which measures the dispersion or spread of the data. A higher standard deviation indicates that the data points for that variable are more spread out from the mean.

Furthermore, the above descriptive statistics indicates that all the variables have similar standard deviations of around 0.50, suggesting moderate variation around their respective means. As for Kurtosis which measures the distribution's shape and whether it has heavy tails or is more peaked than a normal distribution, all the variables have negative kurtosis values, which suggest that their distributions are flatter (less peaked) than a normal distribution. The skewness measuring the asymmetry of the distribution shows that GDP has a positive skewness of 0.52, signifying a slight rightward (positive) skew, which means there may be some outliers on the higher end of the GDP values. However, the other variables have skewness values close to zero, suggesting relatively symmetrical distributions. The minimum and maximum values represent the range of each variable. For example, GDP ranges from a min value of 375.75 to a max value of 574.18.

Table 4.2 below shows the correlation coefficients between GDP and the explanatory variables (EPC, RC, EC, EMC, ERD).

Table 4.2 Correlation Matrix

	GDP	EPC	RC	EC	EMC	ERD
GDP	1					
EPC	0.006924	1				
RC	-0.02083	-0.03561	1			
EC	0.008404	0.010409	-0.01283	1		
EMC	-0.02296	-0.01094	0.020162	0.023715	1	
ERD	-0.04953	-0.0199	0.02559	-0.04043	0.010945	1

Source: Author's Computation (2023)

Correlation is a statistical measure that assesses the linear association between two variables. It ranges from -1 to 1, where a value of -1 represents a perfect negative linear relationship, 1 represents a perfect positive linear relationship, and 0 indicates no linear relationship. The correlation coefficient between GDP and EPC is approximately 0.0069, which is very close to zero. This suggests that there is almost no linear relationship between GDP and EPC. Similarly, the correlation coefficient between GDP and RC is approximately -0.0208, also very close to zero. This indicates a very weak, nearly negligible, negative linear relationship between GDP and RC. In the same vein, the correlation coefficient between GDP and EC which is approximately 0.0084, this is extremely close to zero. This suggests that there is almost no linear relationship between GDP and Exploitation Costs (EC). Also, the correlation coefficient between GDP and EMC is approximately -0.0229, still very close to zero. This implies a very weak, nearly negligible, negative linear relationship between GDP and EMC. As for the correlation coefficient between GDP and ERD which is approximately -0.0495. While this is still relatively small, it suggests a slightly stronger negative linear relationship compared to the other variables. However, it is still relatively weak.

Overall, based on these correlation coefficients, it appears that there are very weak and almost negligible linear relationships between GDP and the various environmental cost variables (EPC, RC, EC, EMC, ERD). This suggests that, at least in terms of linear correlations, the environmental costs are not strongly correlated with linear effects on economic development (GDP). It's essential to note that correlation does not imply causation, and there could be other complex, non-linear relationships or factors. This means further statistical analysis including regression modelling will be necessary to explore these relationships in more depth and determine if there are any significant effects of environmental costs on economic development.

Table 4.3 below is the summary output of an Analysis of Variance (ANOVA) for the regression analysis.

Table 4.3 ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	4170.119	834.0237	0.268201	0.930359
Residual	394	1225222	3109.7		
Total	399	1229392			

Source: Author's Computation (2023)

The sum of squares due to regression is 4170.119. This represents the amount of variance in the outcome variable (GDP) that is explained by the predictors (EPC, RC, EC, EMC, ERD), with a mean square that stands at 834.0237. The F-statistic value of 0.2682 measuring how well the predictor variables collectively explain the variance in the outcome variable, with an associated p-value of 0.930359. For the residual part of the model, there are 394 degrees of freedom. This corresponds to the total number of observations minus the number of parameters estimated in the model.

With respect to the total variance, there are 399 degrees of freedom, which is equal to the total number of observations minus 1. The sum of squared residuals is 1,225,222 representing the unexplained variance in the dependent variable that the regression model did not capture. The p-value tests the null hypothesis that all the regression coefficients (independent variables) are equal to zero. A high p-value (as in this case) suggests that there is no significant relationship between the independent variables and the dependent variable. Therefore, the F-statistic (0.2682) indicates that the independent variables, taken together, do not significantly explain the variance in the dependent variable (GDP). Likewise, the high p-value (0.930359) associated with the F-statistic further suggests that the regression model is not statistically significant, and there is no strong evidence to conclude that the independent variables have a significant impact on economic development (GDP) based on the model.

Table 4.4 Regression Statistics

Multiple R	0.058241
R Square	0.003392
Adjusted R Square	-0.00926
Standard Error	55.76469
Observations	400

Source: Author's Computation (2023)

Table 4.4 above describes the overall performance and goodness of fit of the regression model. R Square is approximately 0.0034, which is very close to zero. This suggests that only about 0.34% of the variance in GDP is explained by the explanatory variables. In other words, the model does not account for much of the variability in GDP. The Adjusted R^2 is a modified version of R^2 that adjusts for the number of independent variables in the model. It penalises the inclusion of extraneous variables that do not increase the fitness of the model. As shown in the Table 4.4, the Adjusted R Square is approximately -0.0093, which is also very close to zero. A negative Adjusted R Square suggests that the model's independent variables are not adding any value in explaining the variance in GDP. The Standard Error is 55.76469 indicating the typical difference between the predicted values from the model and the actual observed values of GDP.

Table 4.5 Regression Analysis

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	464.5739	6.994464	66.42023	0.000003
EPC	0.551752	5.581825	0.098848	0.921309
RC	-2.09705	5.591665	-0.37503	0.707839
EC	0.740848	5.587809	0.132583	0.894591
EMC	-2.46658	5.602601	-0.44026	0.659993
ERD	-5.37098	5.58439	-0.96178	0.336748

Source: Author's Computation (2023)

Table 4.5 above, the estimated intercept or constant term in the regression equation represents the expected value of GDP when all independent variables are zero, with standard error of 6.994464,

measuring the variability of the estimated intercept. The t-statistic has a high absolute value of 66.42023, indicating that the intercept is significantly different from zero. As for the P-value of 0.000003, also has a very low p-value suggesting that the intercept is statistically significant.

The high p-value of 0.921309 attributable to EPC suggests that EPC is not statistically significant in explaining changes in GDP. Its effect is not distinguishable from zero. Similarly, RC with P-value 0.707839 also suggests that RC is not statistically significant in explaining changes in GDP. Likewise, EC (0.894591) suggesting that EC is not statistically significant in explaining changes in GDP. With respect to EMC with Coefficient (-2.46658), representing the estimated impact of a one-unit increase in EMC on GDP, holding all other variables constant, with P-value of 0.659993. The high p-value also suggests that EMC is not statistically significant in explaining changes in GDP. Lastly, ERD with 0.336748 p-value suggesting that ERD is not also statistically significant in explaining changes in GDP.

Therefore, based on the above coefficients and their associated p-values, none of the independent variables (EPC, RC, EC, EMC, ERD) are statistically significant in explaining changes in GDP. The high p-values suggest that these variables do not have a significant impact on economic development (GDP) in a linear regression framework.

5.0 Conclusion and Recommendations.

Based on the analysis conducted, it appears that the relationship between environmental costs (specifically, Environmental Protection Costs, Reduce Costs, Exploitation Costs, Environmental Management Costs, and Environmental Research and Development Costs) and economic development, as represented by Gross Domestic Product (GDP), is not statistically significant.

The results of our statistical data analysis suggest that, within the framework of the current linear regression model, there is

insufficient evidence to support a significant relationship between environmental costs and economic development, as measured by GDP. None of the independent variables, including Environmental Protection Costs, Reduce Costs, Exploitation Costs, Environmental Management Costs, and Environmental Research and Development Costs, demonstrated statistically significant impacts on GDP. The low R-squared value and high p-values indicate that these variables do not explain a meaningful proportion of the variance in economic development.

Based on the findings of this analysis, it is recommended that further research and analysis be conducted to examine the complex relationship between environmental costs and economic development, by consider refining the modeling approach by exploring different functional forms or nonlinear relationships that may better capture the intricate nature of how environmental costs affect economic development. Additional variables that should include other relevant economic and environmental indicators or variables that could provide a more comprehensive picture of the relationship should also be considered. This may involve considering external factors, policy variables, or time-lagged effects. As for the policy implications of the findings, even if the statistical relationship is weak. Environmental management and sustainable development remain critical concerns, and it may be beneficial to align environmental policies with long-term economic objectives.

In summary, while the current analysis did not find a significant linear relationship between environmental costs and economic development, further investigation and a more comprehensive approach are warranted to better understand the complex interplay between environmental factors and economic growth. Such insights can inform evidence-based policy decisions and strategies for achieving sustainable economic development in the future.

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CHAPTER 2

ECO-LITERACY AND ECONOMIC DEVELOPMENT IN NIGERIA: A SYMBIOTIC RELATIONSHIP

A. I. Shuaeeb,[1]

R. M. (PhD) Bello[2]

[1] Department of Science Education
Federal University of Technology, Minna
ai.shuaeeb@futminna.edu.ng +2347065116515
[2] 4Department of Science Education
Federal University of Technology, Minna

INTRODUCTION

Eco-literacy is defined as the understanding of ecological systems and their implications, it has gained recognition for its potential to catalyze sustainable economic development. This research delves into the multifaceted benefits of eco-literacy in driving economic growth while ensuring environmental preservation. Eco-literacy, the understanding of ecological systems and their interdependencies, has gained prominence due to its potential impact on economic development. As societies face environmental challenges, there is a growing recognition that sustainable economic growth necessitates a population well-versed in ecological principles. Eco-literacy equips individuals with the knowledge to make informed decisions about resource management, waste reduction, and sustainable consumption (Orr, 1992). A well-versed population is better positioned to support policies promoting renewable energy adoption (Stern, 2004) and participate in circular economy initiatives (Geissdoerfer et al., 2017), fostering innovation and job creation. Economic growth often places strain on ecosystems, leading to biodiversity loss and climate change (IPBES, 2019). Eco-literacy can help mitigate these impacts by cultivating a culture of environmental stewardship and encouraging a shift towards greener technologies (MEA, 2005). Such practices are integral for industries to adapt and remain competitive in a changing global landscape (Porter & Van der Linde, 1995). Moreover, eco-literacy contributes to sustainable tourism development (Fennell, 2008) and encourages socially responsible investments (UNEP, 2005), enhancing a country's attractiveness to environmentally conscious investors and tourists. This, in turn, can boost local economies and employment opportunities (UNWTO, 2017). The symbiotic relationship between eco-literacy and economic development is becoming increasingly evident. A populace well-versed in ecological understanding can drive policies, practices, and innovations that promote sustainable economic growth, while also preserving the environment for future generations.

ROLE OF ECO-LITERACY IN NIGERIA'S ECONOMY

Eco-literacy's role in economic development is particularly relevant for countries like Nigeria, where environmental challenges and economic growth are intricately linked. This research aims to investigate how enhancing eco-literacy in Nigeria can foster sustainable economic development, considering the country's unique socio-economic and environmental context. Nigeria's rapid economic growth has often come at the expense of its environment, with issues like deforestation, pollution, and resource depletion becoming increasingly pressing (Ogboru & Edewor, 2020). Eco-literacy can empower citizens to understand these challenges and engage in informed decision-making to drive environmentally responsible policies. Eco-literacy's potential impact on Nigeria's economy is two-fold. First, a populace equipped with ecological knowledge can actively participate in sectors like renewable energy and sustainable agriculture (Olayide & Okuneye, 2017). Second, eco-literate individuals can advocate for and support circular economy practices, which have the potential to enhance resource efficiency and promote job creation (Ogbonna & Arinze, 2021). Furthermore, eco-literacy contributes to responsible consumption patterns, reducing waste generation and its associated costs (Adedokun & Sobanke, 2020). This is vital for a country striving for economic growth while managing its environmental impact. Additionally, enhanced eco-literacy can bolster Nigeria's tourism sector, as environmentally conscious travelers seek destinations committed to sustainable practices (Udo-Ekpo & Akpan, 2019). However, challenges such as limited educational resources and infrastructural deficiencies must be addressed to effectively promote eco-literacy (Ogboru & Edewor, 2020). Collaborative efforts involving government, educational institutions, NGOs, and the private sector are essential to develop comprehensive eco-literacy programs tailored to Nigeria's needs.

Other roles played by Eco-literacy in economic development include the following:

i. Eco-literacy equips individuals with the knowledge to make informed decisions regarding resource management and consumption patterns (Orr, 1992). Such informed decision-making translates into increased demand for sustainable products and services, thereby stimulating innovation and fostering economic growth (Dyllick & Hockerts, 2002).

ii. A population well-versed in ecological principles is better poised to support policies and initiatives promoting clean energy adoption (Stern, 2004). This transition to renewable energy sources not only reduces carbon emissions but also generates employment opportunities within the burgeoning green energy sector (International Renewable Energy Agency, 2019).

iii. Eco-literacy also contributes to the emergence of circular economies, where resources are optimized and waste minimized (Geissdoerfer et al., 2017). Citizens who understand the lifecycle of products are more likely to engage in sustainable consumption practices, encouraging businesses to adopt eco-friendly production methods (Blomsma & Brennan, 2017). This shift towards circularity fosters job creation in sectors such

iv. Eco-literacy empowers individuals to make environmentally conscious choices, promoting resource efficiency and reducing waste (Orr, 1992). As people become more knowledgeable about ecological principles, they are better equipped to engage in sustainable consumption and production patterns (Stern, 2004). This shift towards greener practices can lead to cost savings for businesses and improved resource management (Geissdoerfer et al., 2017).

v. Furthermore, eco-literate individuals can spur innovation and entrepreneurship by identifying opportunities for eco-friendly technologies and services (Porter & Van der Linde, 1995). Such

innovation can lead to the creation of new markets and industries, driving economic growth while addressing environmental challenges.

Eco-literacy also plays a pivotal role in shaping policies and regulations conducive to sustainable development (MEA, 2005). Informed citizens are more likely to demand and support environmentally friendly policies, influencing governments to adopt measures that balance economic growth with ecological well-being (Fennell, 2008). The relationship between eco-literacy and economic development extends to sectors like ecotourism, where environmentally aware travelers seek destinations committed to conservation efforts (UNWTO, 2017). This demand generates economic opportunities for local communities and encourages the preservation of natural resources. To conclude, eco-literacy offers a range of benefits for economic development. Informed individuals contribute to efficient resource use, drive innovation, influence policy-making, and enhance sectors like ecotourism, fostering a harmonious coexistence between economic progress and ecological integrity.

POTENTIAL BENEFITS OF PROMOTING ECO-LITERACY IN NIGERIA

Nigeria, a country blessed with abundant natural resources, has faced a complex challenge in balancing economic development with environmental preservation. The concept of eco-literacy, which involves understanding and appreciating ecological systems, offers a promising avenue to address this challenge. The following are the potential benefits of promoting eco-literacy within Nigeria, highlighting how an informed populace can contribute to sustainable economic growth, environmental conservation, and social well-being.

1. **Economic Growth and Resource Efficiency:**
   Eco-literacy equips individuals with the knowledge to make informed decisions regarding resource utilization and waste reduction. Informed citizens are more likely to adopt sustainable practices in sectors like agriculture, energy, and manufacturing

(Olayide & Okuneye, 2017). This increased resource efficiency not only reduces costs but also ensures the longevity of Nigeria's natural assets, contributing to long-term economic stability.

2. **Innovation and Green Entrepreneurship:**
   Eco-literacy fosters a culture of innovation by encouraging individuals to identify environmentally friendly solutions to pressing challenges. Informed citizens can pioneer the development of green technologies, creating new market opportunities and driving economic growth (Geissdoerfer et al., 2017). This potential for innovation aligns with Nigeria's aspirations to diversify its economy beyond oil-dependent sectors.
3. **Sustainable Tourism and Economic Opportunities:**
   The rise of eco-tourism presents a unique avenue for economic growth. Informed tourists seek destinations that emphasize environmental conservation and cultural preservation (Udo-Ekpo & Akpan, 2019). Promoting eco-literacy can attract such travelers, generating revenue and employment opportunities for local communities.
4. **4. Policy Advocacy and Environmental Governance:**
   Eco-literacy empowers citizens to engage in informed discussions and advocate for environmentally responsible policies. An informed populace is more likely to demand and support regulations that balance economic development with ecological well-being (MEA, 2005). This pressure can drive positive changes in industries with significant environmental impacts, such as mining and manufacturing.
5. **5. Challenges and Considerations:**
   While the benefits of eco-literacy are promising, challenges such as limited educational resources and awareness gaps must be addressed. Collaborative efforts involving government agencies, educational institutions, NGOs, and the private sector are essential to develop comprehensive eco-literacy programs tailored to Nigeria's needs (Ogboru & Edewor, 2020).

6. Eco-literacy's potential benefits for the Nigerian economy are extensive, encompassing sustainable resource management, innovation, tourism growth, and policy advocacy. By prioritizing eco-literacy initiatives, Nigeria can foster a more informed, environmentally conscious populace that contributes to both economic prosperity and ecological integrity.

BENEFITS OF ECO-LITERACY TO NIGERIA'S ECONOMY

The benefits of Eco-literacy to Nigeria's Economy include the following:

1. **Green Innovation and Economic Growth:**
   Eco-literacy can stimulate innovation in green technologies and practices, leading to the emergence of new markets and industries (Geissdoerfer et al., 2017). This innovation-driven growth can diversify Nigeria's economy beyond oil-dependence and contribute to higher GDP growth rates.
2. **Improved Resource Management and Cost Savings:**
   Eco-literacy empowers individuals and businesses to adopt sustainable practices, leading to improved resource management and reduced operational costs (Olayide & Okuneye, 2017). This can lead to higher profits for businesses and contribute to a more resilient economy.
3. **Tourism and Job Creation:**
   Promoting eco-literacy can enhance Nigeria's potential for eco-tourism by attracting environmentally conscious travelers (Udo-Ekpo & Akpan, 2019). This influx of tourists generates economic opportunities for local communities, stimulates job creation, and bolsters the tourism sector.
4. **Attracting Green Investments:**
   A well-informed population that values environmental sustainability makes Nigeria more attractive to socially responsible investors (UNEP, 2005). This can lead to increased foreign direct investment and the growth of sustainable businesses.

5. **Long-term Resilience and Climate Adaptation:**
   Eco-literacy equips individuals with the knowledge to adapt to and mitigate the impacts of climate change (MEA, 2005). Enhanced resilience against climate-related disruptions can safeguard economic activities and infrastructure.
6. **Access to Global Markets:**
   As international markets increasingly demand eco-friendly products and services, eco-literate businesses in Nigeria can tap into global markets and export opportunities (Geissdoerfer et al., 2017). This expands market reach and can lead to increased revenues.
7. **Improved Reputation and Competitiveness:**
   Eco-literacy enhances the reputation of businesses and industries that prioritize sustainability (Porter & Van der Linde, 1995). Such businesses are likely to attract more customers, partners, and investors, ultimately contributing to their competitiveness in the market.
8. **Enhanced Energy Efficiency:**
   Eco-literacy promotes the adoption of energy-efficient practices and technologies, reducing energy consumption and costs for individuals and businesses alike. This translates into savings that can be reinvested into the economy (Stern, 2004).
9. **Circular Economy Adoption:**
   With a strong foundation in eco-literacy, Nigeria can transition towards a circular economy, where resources are conserved, reused, and recycled. This approach minimizes waste generation and resource depletion, contributing to long-term economic sustainability (Geissdoerfer et al., 2017).
10. **Reduction in Healthcare Costs:**
    A population well-versed in eco-literacy is more likely to adopt healthy and sustainable lifestyles, leading to reduced healthcare costs in the long run. This is achieved by

minimizing pollution-related health issues and promoting well-being (Stern, 2004).

Eco-literacy offers a multitude of benefits to Nigeria's economy, encompassing innovation, resource efficiency, tourism growth, access to global markets, and more. By fostering a culture of environmental consciousness, Nigeria can harness these advantages to drive sustainable economic development, improve quality of life, and position itself as a leader in the global movement towards a greener future.

CONSTRAINTS AND CHALLENGES OF ECO-LITERACY IN NIGERIA

Eco-literacy, the understanding of ecological principles and their applications, is crucial for sustainable development. However, in the Nigerian context, several constraints and challenges impede the widespread adoption of eco-literacy and these include:

1. **Educational Disparities and Awareness Gap:**
   Nigeria faces educational disparities and a lack of awareness about environmental issues, contributing to a limited understanding of eco-literacy (Ogboru & Edewor, 2020). Unequal access to quality education and resources perpetuates a cycle where many individuals lack the knowledge needed to make informed decisions regarding ecological preservation and sustainable practices.
2. **Limited Infrastructure and Access to Information:**
   Limited access to technology and information hampers the dissemination of eco-literacy. Many rural areas lack the infrastructure needed to access educational materials and resources related to environmental awareness and conservation (UNDP, 2019). This digital divide exacerbates the challenge of promoting eco-literacy across diverse segments of the population.

3. **Cultural and Socio-economic Factors:**
   Cultural beliefs and socioeconomic factors can hinder the adoption of eco-literacy practices. Traditional practices and values may conflict with modern concepts of environmental conservation (Aina & Abimbola, 2016). Additionally, pressing economic concerns may take precedence over long-term environmental considerations for individuals struggling to meet basic needs.
4. **Lack of Institutional Support:**
   Insufficient institutional support, including inadequate policies and regulations, further constrains the promotion of eco-literacy. Weak enforcement of environmental laws and a lack of incentives for sustainable practices discourage individuals and businesses from prioritizing ecological awareness (Ogboru & Edewor, 2020).
5. **Infrastructure Challenges and Urbanization:**
   Rapid urbanization places additional stress on Nigeria's ecosystems. Poor urban planning, inadequate waste management systems, and limited green spaces hinder the integration of eco-friendly practices in urban areas (UNDP, 2019). These challenges underscore the need for comprehensive policies that align economic development with ecological sustainability.

The constraints and challenges surrounding eco-literacy in Nigeria's economy and society are multifaceted and interconnected. Addressing these obstacles requires collaborative efforts involving government, educational institutions, NGOs, and the private sector. Initiatives should focus on improving educational access, raising awareness, bridging the digital divide, and creating policies that incentivize environmentally responsible practices. By overcoming these challenges, Nigeria can pave the way for a more eco-literate populace that contributes to sustainable development and environmental preservation.

POSSIBLE SOLUTIONS TO ECO-LITERACY CHALLENGES AND CONSTRAINTS

Addressing the constraints and challenges related to eco-literacy in Nigeria requires a multi-faceted approach that involves collaboration among various stakeholders. This section presents potential solutions to overcome these obstacles and promote eco-literacy for sustainable development.

1. **Enhancing Educational Access and Awareness:**
   Implement programs to improve access to quality education, particularly in rural areas, and integrate eco-literacy into the curriculum (UNDP, 2019).
   Utilize community outreach and media campaigns to raise awareness about environmental issues and the importance of eco-literacy (Ogboru & Edewor, 2020).
2. **Bridging the Digital Divide:**
   Develop initiatives to provide affordable access to technology and the internet, facilitating the dissemination of eco-literacy resources to underserved populations (UNDP, 2019).
   Create digital platforms and mobile applications that offer eco-literacy content and interactive learning opportunities (Ogboru & Edewor, 2020).
3. **Promoting Cultural Integration:**
   Collaborate with local communities and cultural leaders to highlight the compatibility between traditional practices and modern eco-literacy principles (Aina & Abimbola, 2016).
   Incorporate indigenous knowledge and practices into eco-literacy programs to make them more relatable and acceptable (UNDP, 2019).
4. **Strengthening Institutional Support:**
   Enforce existing environmental laws and regulations while also introducing incentives for businesses and individuals to adopt sustainable practices (Ogboru & Edewor, 2020).

Develop partnerships between governmental bodies, NGOs, and private sectors to collectively promote eco-literacy and sustainable development (UNDP, 2019).

5. **Integrating Eco-literacy into Urban Planning:**
   Incorporate eco-literacy principles into urban planning processes to ensure sustainable infrastructure development, waste management, and green space allocation (UNDP, 2019).
   Establish public awareness campaigns in urban centers to encourage environmentally friendly behaviors (Ogboru & Edewor, 2020).
6. **Creating Eco-literacy Training for Teachers:**
   Develop specialized training programs for educators to equip them with the knowledge and tools to effectively teach eco-literacy concepts in schools (UNDP, 2019).
   Integrate eco-literacy into teacher education curricula to ensure a sustainable flow of informed educators (Ogboru & Edewor, 2020).
7. **Establishing Eco-literacy Centers and Hubs:**
   Set up eco-literacy centers or hubs that provide accessible resources, workshops, and interactive learning experiences for individuals of all ages (UNDP, 2019).
   Collaborate with community organizations to create local eco-literacy hubs that cater to the specific needs of different regions (Ogboru & Edewor, 2020).
8. **Fostering Cross-disciplinary Collaboration:**
   Encourage collaboration between environmental experts, economists, sociologists, and other professionals to develop comprehensive solutions that integrate eco-literacy across sectors (Aina & Abimbola, 2016).
   Organize interdisciplinary workshops and seminars to facilitate knowledge exchange and problem-solving.
9. **Showcasing Successful Case Studies:**

Highlight successful examples of eco-literacy initiatives from other countries to inspire and motivate Nigerian stakeholders (UNDP, 2019).

Showcase local success stories through media platforms to demonstrate the tangible benefits of eco-literacy adoption (Ogboru & Edewor, 2020).

10. **Monitoring and Evaluation:**

Establish mechanisms to monitor the effectiveness of eco-literacy programs and initiatives, gathering data on knowledge acquisition and behavior change (UNDP, 2019).

Use evaluation results to refine and improve eco-literacy strategies over time, ensuring their relevance and impact (Ogboru & Edewor, 2020).

Implementing these solutions requires coordinated efforts and commitment from government agencies, educational institutions, NGOs, and the private sectors, which can significantly contribute to overcoming the constraints and challenges associated with eco-literacy in Nigeria's economy and society. By fostering a comprehensive approach that encompasses education, awareness, policy, culture, and technology, Nigeria can gradually build an eco-literate population that actively engages in sustainable practices and drives positive change and also promote a more informed and environmentally conscious populace, leading to sustainable development and a healthier environment.

RECOMMENDATIONS

These recommendations are derived from the aforementioned possible solutions to the challenges facing Eco-literacy in Nigeria.

1. **Integrate Eco-Literacy into Formal Education:** Embed eco-literacy principles into the national curriculum at all levels of education. This can be achieved by creating dedicated courses or incorporating eco-friendly concepts into existing subjects. Additionally, teacher training programs should emphasize the importance of eco-literacy in shaping a sustainable future.

2. **Promote Awareness Campaigns:** Launch nationwide awareness campaigns to educate the public about environmental issues and the benefits of eco-friendly practices. Utilize various media platforms, community events, and workshops to disseminate information and encourage behavioral change.
3. **Establish Eco-Centric Businesses:** Encourage the growth of businesses that prioritize environmental sustainability. Offer incentives, grants, and loans to entrepreneurs and startups focusing on green technologies, renewable energy, waste management, and sustainable agriculture.
4. **Invest in Research and Innovation:** Allocate funding for research and development in eco-friendly technologies and practices. Support universities and research institutions to explore sustainable solutions for sectors such as agriculture, energy, water management, and transportation.
5. **Collaborate with Indigenous Knowledge:** Acknowledge and incorporate indigenous knowledge and practices that are inherently eco-friendly. Collaborate with local communities to create a holistic approach that merges traditional wisdom with modern sustainability efforts.
6. **Enhance Environmental Governance:** Strengthen and enforce environmental regulations and policies. Implement penalties for unsustainable practices and reward businesses that adopt eco-friendly approaches. Government agencies should work together to ensure compliance and promote sustainable practices.
7. **Create Green Jobs:** Develop training programs and initiatives that prepare individuals for careers in the growing green economy. This includes jobs in renewable energy, conservation, environmental consulting, and sustainable agriculture.
8. **Support Eco-Tourism:** Invest in eco-tourism infrastructure and initiatives that showcase Nigeria's natural beauty while emphasizing responsible tourism practices. This can generate revenue, create jobs, and raise awareness about the importance of preserving the environment.

9. **Encourage Community Engagement:** Empower local communities to take ownership of environmental initiatives. Support community-led conservation projects, tree planting campaigns, and sustainable resource management practices.
10. **Establish Eco-Literacy Centers:** Create dedicated centers or hubs where people can access information, resources, and workshops on eco-literacy. These centers can serve as focal points for community engagement and learning.
11. **Public-Private Partnerships:** Foster collaboration between government, private sector, non-profit organizations, and academia to collectively promote eco-literacy and sustainable economic development.
12. **Monitor and Evaluate Progress:** Regularly assess the impact of eco-literacy initiatives on economic development and environmental conservation. Use data to fine-tune strategies and allocate resources effectively.

By implementing these recommendations, Nigeria can foster a culture of eco-literacy that not only drives economic growth but also contributes to a healthier environment and a more sustainable future.

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CHAPTER 3

THE EFFECTS OF INDUSTRIALIZATION AND FINANCIAL DEVELOPMENT ON CARBON EMISSIONS IN UGANDA

Ibrahim Mukisa (PhD)[1]

Philemon Okillong[2]

Justine Luwedde [2]

[1] Makerere University, School of Economics. Corresponding author, email: mukisaibrahim@yahoo.com & ibrahim.mukisa@mak.ac.ug
[2]Economic Policy Research Centre, Makerere University

1.0 INTRODUCTION

The world recognizes carbon emissions as one of the most contentious issues in global warming (Ahmad & Khattak, 2020; Fallahi, 2020). It is noted that Industry consumes a great amount of energy and contributes to carbon dioxide (CO_2) emissions via increased industrial activity that leads to degradation of the environment. Hence policy makers have focused on curtailing carbon emissions from energy production and industrial actions owing to the global environmental protection guidelines which hinder economic development (Zafar, 2019). Developing countries particularly face pressure to pursue economic development which brings about efforts to increase their output as opposed to protection of their environment (Jiang and Ma, 2019).

Despite of the global focus, carbon emissions are on a continual increase, reaching a record high of 33 billion tonnes in 2021 (International Energy Agency, 2021). The increase in the effects of climate change will likely intensify the existing economic and social challenges worldwide, especially for developing countries.

Financial development has been considered as a key factor in increasing carbon emissions though not in specific terms (Jiang and Ma, 2019). Some scholars argue that financial development may attract foreign direct investment (FDI) in order to hasten economic growth thereby increasing carbon emissions (Frankel and Romer, 1999; Sadorsky, 2010). Others such as Tamazian *et al.* (2009) argue that financial development enables enterprises to increase innovation in technology and implement new technologies, which in turn improves energy efficiency and low carbon development hence low carbon emissions.

1.1 Problem Statement

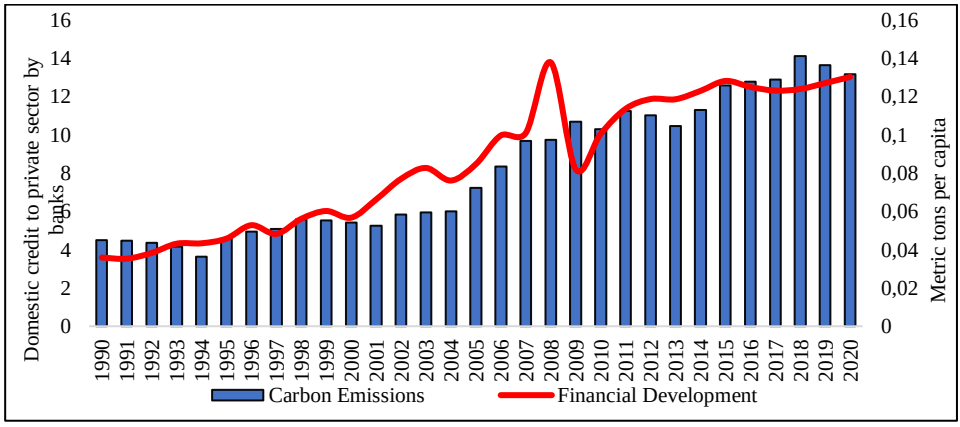
In Uganda, industry accounts for about 0.099 percent of global carbon stock (Appiah *et. al,* 2019). However, the country is still susceptible to climate change impacts much as it has a lower contribution to the world carbon stock of approximately 1.39 tons of

CO2 less than the world average estimated at 7.99 tons of carbon emissions per capita (Environment, 2015).

The Uganda government is cognizant of the vulnerabilities to climate change and has made commitments to implement policies on sustainable economic development to address Uganda climate change challenges and increase the production of domestic renewable energy. The Uganda government also initiated a National Greenhouse Gas (GHG) Inventory Scheme founded on the Paris Agreement for Climate Change and also set a GHG emissions reduction target at 22 percent by 2030, which is however conditioned on external financial support of 70 percent of the required budget therefore necessitating financial boost to achieve this goal.

Therefore, actions to tackle climate change and its effects on the environment require significant policy measures (Walters, 2021). In addition, achieving Sustainable Development Goal (SDG) 13 necessitates extensive reductions of emissions via deliberate adaptation and mitigation policies. This study is timely in analysing industrialization, financial development and carbon emission to enable the formulation and implementation of policy to mitigate effects of climate change. Figure 1 shows the increasing trends and graphical relationships between industrialization, financial development and carbon emission in Uganda between 1990-2020. The trends reveal a positive correlation between them. This raises a policy concern of whether improvements in Uganda's industrial and financial structure have an implication to the rising carbon emissions.

Therefore, it is against this background that this study examines the effects of industrialization and financial development on carbon emissions in Uganda by adopting both a linear and nonlinear methodological approach. To provide policymakers and development actors with comprehensive evidence, the study uses a simple and flexible non-linear dynamic approach developed by Shin et al., (2014).



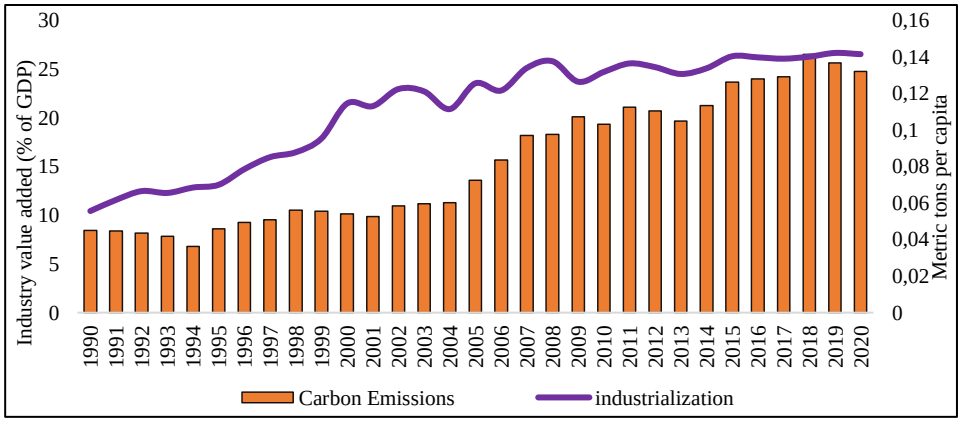


Figure 1: Relationship between Financial Development, Industrialization and Carbon Emissions in Uganda (1990 - 2020)

Source: Authors Own construction using data from the World Development Indicators (WDI, 2021).

1.2 Study Purpose and Objectives

The main purpose of this study is to investigate the effects of industrialization and financial development on carbon emissions in Uganda. Specifically, it aims:

i) To examine the short-run and long-run effects (both linear and non-linear) of industrialization on carbon emissions in Uganda
ii) To analyse the short-run and long-run effects (both linear and non-linear) of financial development on carbon emissions in Uganda

2.0 Literature

The ecological modernization theory suggests that there is a non-linear relationship between industrialization and the quality of the environment. The argument is that in the early phase of modernization, industrialization development is minimal which brings about environmental problems. Majeed & Mazhar (2019) argue that in the long run however, environmental problems are lessened with the introduction of modern technologies that are eco-friendly combined with increased public awareness about the quality of the environment.

Majeed & Mazhar (2019) further argue that financial development is key in determining the quality of the environment. According to literature, financial development affects carbon emissions both positively and negatively. First, production activities are financed by the financial sector which bring about pollution in cases where production is reliant on conservative forms of energy, industrialization and technologies that are pollution intensive. In addition, financial development is a source of attraction for foreign direct investment, which destroys the environment especially if regulations pertaining to the environment are inadequate.

Appiah et al, (2019) studied the causal relationship between carbon emissions, energy intensity, industrialization, and economic expansion in Uganda between 1990 to 2014. They adopt the autoregressive distributed lag (ARDL) approach and find that in the long-run, economic growth and industrialization grow by of 1 percent which increases carbon emission by 31.1 percent and 3.2 percent respectively whereas a 1 percent increase in energy intensity reduces emissions by 83.9 percent. They conclude that combined effects of energy intensity, economic progress and industrialization kept at a constant lead to a reduction of emissions by 2.46 percent in Uganda.

Asumadu-Sarkodie and Owusu (2016) examined the causal linkage between carbon emissions, energy use, industrialization, and financial development in Sri Lanka from 1971 to 2012. Using the ARDL approach, they find a unidirectional causal linkage between

carbon emissions to the consumption of energy, whereas they find a bidirectional causal linkage between industrialization and energy use, which determines carbon emissions. Asumadu-Sarkodie and Owusu (2017) studied the causal connection between carbon emissions and industrialization between 1965–2011 in Rwanda. Using the ARDL model, they find a long-run relationship among the variables. They further found a positive effect of industrialization on carbon emissions was found to be positive, which in turn affects the environment.

Zhang (2011) examined the impact of financial development on carbon emissions in China for a 30-year period. They use a cointegration test and the measure of variance decomposition. They find that financial development has a positive and significant effect on carbon emissions. Sadorsky (2010) used panel data from 22 developing countries to analyze the nexus of financial development, energy consumption, and carbon emissions. The result shows that for these countries, financial development leads to more energy use that produces more carbon emissions.

On the contrary, a growing body of literature has agreed that financial development reduces environmental degradation via the promotion of economic growth. Ozturk and Acaravci (2010) examined the long-run relationship between carbon emissions per capita, real income per capita, the square real income per capita squared, and financial development in Turkey. The findings show that real income per capita at a higher degree leads to a reduction in carbon emissions.

Conclusively, this study attempts to fill the literature gap given that literature is scanty in the case of Uganda as findings from empirical literature are mixed and vary across countries and regions. Secondly, few studies have been undertaken in the particular context of Uganda (for instance: Appiah et al, (2019), and to the best of our knowledge, there are no studies that examine and model the possibility of nonlinearity in the relationship between industrialization, financial development and carbon emissions in Uganda. If this relationship is genuinely nonlinear, then the present studies that are based on the

linearity assumption should be revisited as their inferences and forecasts may be imperfect and misleading.

3.0 Methodology

3.1 Study Scope

This study examines the effects of Industrialization and Financial development on carbon emissions in Uganda using timeseries analysis for a period of thirty (31) years from 1990 to 2020.

3.2 Empirical Methodology

As part of its analytical framework, the study adopts the EKC (Ecological Kuznets Curve) hypothesis, which postulates that economic growth could essentially lead to environmental degradation (Kuznets, 1955). In the same vein, Grossman and Krueger (1995) stressed that the nexus between economic growth and environmental degradation form an inverted U shape. The EKC hypothesis has been broadly used to investigate the effect of economic development (as well as other factors including industrialization, financial development, urbanization, and trade openness among others) on Carbon emissions (For a review: see Sikder et. al., 2022; Nurgazina et. al., 2021).

Grounded on the EKC hypothesis, the study investigates the linkage between major determinants of the economy and carbon emissions in Uganda. These determinants include industrialization, trade openness, population, urbanization, and financial development (Tang & Tan, 2015; Nurgazina et. al., 2021; Sikder et. al., 2022). Following previous literature, the study specifies a general functional model denoted as:

$$CO_{2t} = f(IND, FD, TOPEN, POP, URB, GDP) \quad (1)$$

Where: CO_{2t} denotes carbon emissions, as IND FD TOPEN POP URB GDP represents the industry structure, financial development, trade openness, population growth, urbanization, and gross domestic product, respectively. Basing on theoretical perspectives by (Sikder *et. al.,* 2022; Nurgazina *et. al.,* 2021), the study specifies an empirical model denoted as:

$$lnCO_{2t} = \alpha_o + \alpha_1 lnIND_t + \alpha_3 lnFD_t + \alpha_4 lnTOPEN_t + \alpha_5 lnPOP_t + \alpha_6 URB_t + \alpha_7 GDP_t + \varepsilon_t \quad (2)$$

where ε_t is the stochastic error term and α_o displays the intercept term, and α_1, α_2, α_3, α_4, α_5, α_6, and α_7 are the parameters of the study variables.

The study follows Nurgazina *et. al.,* (2021) and Sikder *et. al.,* (2022) by adopting an Autoregressive Distributed Lag bounds (ARDL) model specification without nonlinearity in short run and long run denoted as:

$$\begin{aligned}\Delta lnCE_t &= \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnCE_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta IND_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta FD_{t-i} \\ &+ \sum_{i=0}^{n} \beta_{4i} \Delta GDP_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta TOPEN_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta URB_{t-i} \\ &+ \sum_{i=0}^{n} \beta_{7i} \Delta POP_{t-i} + \varphi_1 lnCE_{t-1} + \varphi_2 IND_{t-1} + \varphi_3 FD_{t-1} + \varphi_4 GDP_{t-1} \\ &+ \varphi_5 TOPEN_{t-1} + \varphi_6 URB_{t-1} + \varphi_7 POP_{t-1} \\ &+ \varepsilon_{t,} \end{aligned} \quad (3)$$

Where Δ denotes the first difference, β_0 is the constant term, the short run and long run coefficients are denoted as $\beta_1, \dots, \beta_7$ and $\varphi_1, \dots, \varphi_7$ respectively, and ε_t is the stochastic error term.

Furthermore, the study uses a flexible parametric framework – Nonlinear Autoregressive Distributed Lag bounds (NARDL) – developed by Shin *et al.,* (2014) to model the nonlinear effects of industrialization and financial development on carbon emissions.[2] Through the decomposition of the major variable of interest (industrialization and financial development) into partial sum processes

[2] Shin et al., (2014) dynamic framework extends the ARDL approach developed by Pesaran and Shin (1999) and Pesaran et al. (2001) to model relationships that exhibit combined short- and long-run nonlinearities.

of both positive and negative components to capture their nonlinear effects on carbon emissions in Uganda. The two components developed to represent these effects include:

Negative component

$$IND_t^- = \sum_{j=1}^{t} \Delta IND_j^-$$

$$= \sum_{j=1}^{t} min(\Delta IND_j, 0), \qquad (4a)$$

$$FD_t^- = \sum_{j=1}^{t} \Delta FD_j^-$$

$$= \sum_{j=1}^{t} min(\Delta FD_j, 0), \qquad (4b)$$

Positive component

$$IND_t^+ = \sum_{j=1}^{t} \Delta IND_j^+$$

$$= \sum_{j=1}^{t} max(\Delta IND_j, 0), \qquad (5a)$$

$$FD_t^+ = \sum_{j=1}^{t} \Delta FD_j^+$$

$$= \sum_{j=1}^{t} max(\Delta FD_j, 0), \qquad (5b)$$

Whereas IND_t^- and IND_t^+ denote the partial sum processes of the negative (decreases) and positive (increases) changes in Uganda's industrial structure in the period (t), the FD_t^- and FD_t^+components represent negative and positive variations in the country's financial

development. To examine the short run and long run nonlinear effect of industrialization and financial development on carbon emissions in Uganda, this study extends the traditional ARDL model in equation (3) by incorporating the positive and negative components as follows:

$$\begin{aligned}\Delta lnCE_t = \beta_0 &+ \sum_{i=1}^{n} \beta_{1i} \Delta lnCE_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta IND_{t-i}^{-} + \sum_{i=0}^{n} \beta_{3i} \Delta IND_{t-i}^{+} \\ &+ \sum_{i=0}^{n} \beta_{4i} \Delta FD_{t-i}^{-} + \sum_{i=0}^{n} \beta_{5i} \Delta FD_{t-i}^{+} + \sum_{i=0}^{n} \beta_{6i} \Delta GDP_{t-i} \\ &+ \sum_{i=0}^{n} \beta_{7i} \Delta TOPEN_{t-i} + \sum_{i=0}^{n} \beta_{8i} \Delta URB_{t-i} \\ &+ \sum_{i=0}^{n} \beta_{9i} \Delta POP_{t-i} + \varphi_1 lnCE_{t-1} + \varphi_2 IND_{t-1}^{-} \\ &+ \varphi_3 IND_{t-1}^{+} + \varphi_4 FD_{t-1}^{-} + \varphi_5 FD_{t-1}^{+} + \varphi_6 GDP_{t-1} \\ &+ \varphi_7 TOPEN_{t-1} + \varphi_8 URB_{t-1} + \varphi_9 POP_{t-1} \\ &+ \varepsilon_{t,} \qquad (6)\end{aligned}$$

Where, the superscripts (−) and (+) represent the negative and positive partial sum decompositions of Industrialization and financial development. According to Shin et al., (2014), equation (6) can be estimated using a procedure similar to equation (3).

3.3 Estimation Procedure

To investigate the effect of industrialization and financial development on carbon emissions, the study begins by examining the stationarity of the variables using the Augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) unit root tests (Dickey & Fuller, 1976; Phillips & Perron, 1988). Additionally, following Pesaran *et. al.,* (2001), the study uses the ARDL bounds testing approach in determining the cointegration (long-term) relationship between the variables with the different orders of integration, and subsequently estimate the long-run and short-run elasticities of the variables.

Using the NARDL dynamic framework developed by Shin *et. al.,* (2014), the study extends the ARDL approach developed by Pesaran & Shin (1999) and Pesaran *et. al.,* (2001) to model the short run and long run nonlinear relationships among the major variables of interest. Finally, the study undertakes several diagnostic tests to confirm compliance with classical linear regression model assumptions. These tests include the Parameter stability test (Ploberger & Kramer, 1992); Heteroscedasticity test (Breusch & Pagan, 1979); Serial correlation test (Durbin & Watson, 1971); Normality test (Jarque & Bera, 1987); Regression specification test (Ramsey, 1969); and Multicollinearity test.

3.4 Data and Sources

The study uses annual timeseries data for Uganda between the period 1990 and 2020. All the variables in the study are obtained from the World Banks' World Development Indicators (WDI, 2021) as shown in Table 1 below. Additionally, the table shows the expected sign of the effect of the several variables on carbon emissions.

Table 1: Variable description and data sources

	Acronym	Variable	Description	Expected Sign	Source
1	CE	Carbon Emissions	CO_2 emissions (metric tons per capita)	Positive	WDI
2	IND	Industry Structure	Industry (including construction), value added (annual % growth)	Positive	WDI
3	FD	Financial Development	Domestic credit to private sector by banks (% of GDP)	Positive	WDI
4	TOPEN	Trade Openness	Trade (% of GDP)	Positive	WDI
5	URB	Urban population	Urban population growth (annual %)	Positive	WDI
6	GDP	Economic Growth	GDP per capita growth (annual %)	Positive	WDI

Source: Author's own construction

4.0 Findings

4.1 Descriptive Results

Table 2 shows the descriptive statistics of the variables used in the study covering a period of thirty-one (31) years. The average value of CO_2 emissions (measured as metric tons per capita) between 1990 and 2020 is 0.082, with a minimum and maximum value of 0.036 and 0.141, respectively. Whereas the average value of financial development and Industrial structure is 8.565 and 8.612 respectively. Furthermore, the study carried out a correlation analysis as shown in Table A.1 (see appendix) to explore the nature of the relationship among the study. Additionally, the study examines Variance Inflation Factors (VIFs) in Table A.2 (see appendix) to check if the model suffers from multicollinearity. Since the Mean VIF of 2.503 is below the acceptable figure of 10, the model is free from the problem of multicollinearity (O'brien, 2007).

Table 2: Descriptive Statistics of the study variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
CE	31	0.082	0.035	0.036	0.141
FD	31	8.565	3.44	3.529	13.786
IND	31	8.612	3.979	2.143	20.256
GDP	31	3.105	2.286	-0.423	8.526
URB	31	5.834	0.35	5.458	7.006
TOPEN	31	36.835	6.297	26.61	56.258

Source: Authors own construction

4.2 Stationarity and Cointegration Tests

Although the ARDL and NARDL techniques may be utilised regardless of the order of integration (I(0), I(1), or both), they may not be useful if the model contains an I(2) series (Pesaran et al., 2001). Therefore, the study uses the ADF and PP tests to examine the presence of unit roots to ensure that none of the series is I(2) or above. Table 3 shows that at a 5 percent level of significance, financial development, industrialization, and GDP per capita are stationary in levels, whereas CO_2 emissions, Urbanization, and Trade Openness are stationary in their first difference. The stationarity test results conclude that all variables under study are either stationary in levels or in their first

difference. Therefore, Since the variables under study have a mixed order of integration [i.e., I (0) and I (1)], the study adopts the ARDL procedure over the Ordinary Least Square (OLS) or Vector Autoregressive (VAR) models as the preferred estimation technique to examine the cointegration relationship between the variables.

Table 3: Results of the Unit Root Tests

Variable	**Level** (Trend and Intercept)		**First difference** (Trend and Intercept)		**Verdict**
	ADF	**PP**	**ADF**	**PP**	
CE	0.0158	-2.5649	-5.0125***	-4.9354***	I (1)
FD	-4.8133***	-4.8116***	-8.9813***	-24.503***	I (0)
IND	-3.6984**	-4.6042***	-5.4155***	-10.519***	I (0)
GDP	-4.2018**	-4.1909**	-6.2224***	-16.433***	I (0)
URB	-3.0312	-3.5695*	-4.3605***	-4.2934***	I (1)
TOPEN	-2.3692	-2.3009	-5.8069***	-11.557***	I (1)
Source: Author's computation; Note: *** *p<0.01, ** p<0.05, * p<0.1*					

Additionally, the study examines the presence of a long run relationship in the variables using the F-Bounds cointegration Test proposed by Pesaran *et. al.,* (2001) as shown in Table 4 below. The results show that the null hypothesis – No levels relationship – is rejected since the F-statistic value of (i.e., 4.6507) is larger than the upper bound critical value (i.e., 4.6507) at a 5 percent significance level, implying that the variables are cointegrated. Therefore, the study proceeds to estimate the model in an error correction form.

Table 4: F-Bound Test Results

Test Statistic	**Value**	**Significance**	**I(0)**	**I(1)**
F-statistic	4.650753	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Null Hypothesis: No levels relationship. Source: Authors own construction

4.3 Diagnostic Tests

Table 5 shows the several diagnostic tests were performed to ensure that the results generate are valid and reliable. The findings show that the model does not suffer from the problem of serial correlation and heteroskedasticity since the P-values of the tests (i.e., 0.1298 and 0.9782 respectively) are greater than 5 percent significance level. Similarly, since the P-values of the Jarque-Bera normality test and Ramsey RESET test are greater than 5 percent significance level, the model has a normal distribution and is well specified.

Table 5: Diagnostic Test Results

Model Diagnostic	F-statistic	P-value	Decision
Serial correlation LM test	2.346956	0.1298	No serial correlation
Heteroskedasticity test	0.293292	0.9782	No heteroskedasticity
Jarque-Bera test on normality	2.479117	0.289512	The distribution is normal
Ramsey RESET test	0.214581	0.6494	The model is well specified

Source: Author's computation and compilation

Furthermore, the study examines the stability of the estimates using the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMQ) tests as shown in Figure A.1 and A.2 in the appendix. The results show that the parameters of the model are stable at a 5 percent significance level, because the plot of the CUSUM and CUSUMQ lines lie within the two red-colored confidence band.

Additionally, the study plots the Cumulative Dynamic Multiplier variations of Industrialization and Financial development on CO_2 emissions to examine the presence of a nonlinear relationship (see Figure A.3 and A.4 in the appendix). The asymmetry line (dotted red line) shows the difference between the negative and positive multiplier effects over the years considered in this study. In the case of a linear relationship, both multiplier effects for a negative (black dotted line) and positive (black line) variation would converge with the line of

asymmetry. Therefore, the results in Figure A.3 provides evidence that the relationship between industrialization and CO_2 emissions is nonlinear since the change in CO_2 emissions as a result of a positive change in industrialization (IND^+) is greater than the change in CO_2 emissions due to a negative change in industrialization (IND^-). However, Figure A.4 reveals the presence of a linear relationship between financial development and CO_2 emissions, as the variations converges with the line of asymmetry.

4.4 Presentation and Discussion of Results

With evidence of the presence of a cointegrating relationship, the study employs a general-to-specific approach to estimate a linear ARDL model before estimating a Nonlinear ARDL model as shown in Table 4.6. The study used the Akaike Information Criterion (AIC) as the lag selection criteria to select the optimal lags for the different variables (while allowing for a maximum of two lags). The optimal lag length is ARDL (1, 1, 1, 2, 0, 1) and NARDL (2, 1, 0, 2, 2, 2, 1, 2).

The findings from the ARDL model (see Panel A) show that financial development and industrialization have a positive and significant effect on CO_2 emissions in the long run. More succinctly, for each unit increase in financial development, CO_2 emissions is estimated to increase by 0.011767 in the long run (at a 1 percent significance level). Similarly, a one unit increase in industrialization tends to increase CO_2 emissions by 0.007632 in the long run (at a 5 percent significance level). However, GDP per capita, urbanization, and trade openness do not appear to have a statistically significant effect on CO_2 emissions in the long run as their coefficients are not significant at conventional levels. In the short run however, only industrialization has a significantly positive effect on CO_2 emissions (at a 5 percent significance level). In particular, a one-unit increase in industrialization leads to a 0.001026 unit increase in the dependent variable in the short run. Similarly in the short run, the coefficient of the lagged GDP shows that a one-unit increase in the lagged GDP per capita change leads to a 0.001114 unit increase in CO_2 emissions (at a 5 percent significance

level). These results are consistent with the findings of Zhang (2011); Asumadu-Sarkodie and Owusu (2017); Majeed & Mazhar (2019).

On the other hand, the findings from the NARDL model (see Panel B) provide more detailed findings with regard to the positive and negative changes in industrialization and financial development on CO_2 emissions. Positive variations in financial development and industrialization have a significantly positive impact on CO_2 emissions, both in the short run and the long run (at a 1 percent significance level). On the other hand, a Negative variation in industrialization has significant effect in lowering the amount of CO_2 emissions both in the short run and long run (at a 1 percent). However, a negative variation in financial development has an insignificant effect on CO_2 emissions in Uganda. Similarly, this finding complements the findings of Tamazian *et. al.,* (2009); Sadorsky, (2010); Majeed & Mazhar (2019); Appiah *et. al.,* (2019).

Focusing on the control variables, the results show that urbanization has a positive and significant effect on CO_2 emissions both in the short run and long run (at a 1 percent significance level). Similarly, trade openness has a significantly positive effect on CO_2 emissions only in the long run. Whereas GDP per capita has a negative effect on CO_2 emissions in the long run, the lagged GDP per capita leads to a positive and significant effect on CO_2 emissions in the short run (at a 1 percent significance level).

Table 6: Empirical Results

Dependent: CO_2 emissions (metric tons per capita)			
Panel A – ARDL Model		**Panel B – NARDL Model**	
Variable	**Coefficient**	**Variable**	**Coefficient**
Long Run			
Constant	-0.022854*** (0.169943)	Constant	-0.198110*** (0.039563)
FD	0.011767*** (0.002215)	FD (Positive)	0.004069*** (0.000873)
IND	0.007632** (0.003465)	FD (Negative)	-0.000367 (0.001113)
GDP	-0.013777 (0.008097)	IND (Positive)	0.004344*** (0.000582)
URB	-0.013775	IND (Negative)	-0.003320***

	(0.026872)		(0.000603)
TOPEN	0.001878 (0.001734)	GDP	-0.003079** (0.001297)
		URB	0.031061*** (0.005552)
		TOPEN	0.001073** (0.000356)
Short Run			
Δ FD	0.000908 (0.000662)	Δ FD (Positive)	0.003369*** (0.000880)
Δ IND	0.001026*** (0.000312)	Δ IND (Positive)	0.001465*** (0.000402)
Δ GDP	-0.000442 (0.000447)	Δ IND (Negative)	-0.001163*** (0.000289)
Δ GDP (-1)	0.001114*** (0.000342)	Δ GDP	0.000171 (0.000315)
Δ (TOPEN)	0.0000789 (0.000198)	Δ GDP (-1)	0.002536*** (0.000485)
Error Correction Term	-0.275931*** (0.041577)	Δ URB	0.021707*** (0.005136)
		Δ TOPEN	0.0000792 (0.000133)
		Error Correction Term	-0.602920*** (0.176099)
Observations R-squared Adjusted R-squared	31 0.637460 0.558647	Observations R-squared Adjusted R-squared	31 0.887837 0.810725

*Note: The asterisks ***, ** and * are respectively at the 1%, 5% and 10% significance level.*

5.0 Conclusion and Policy Recommendations

This study examines the effects of Industrialization and Financial development on carbon emissions in Uganda using time series analysis for a period of thirty (31) years from 1990 to 2020 using data from the World Banks' World Development Indicators (2021). The study uses the ARDL bounds testing approach in determining the cointegration (long-term) relationship between the variables with the different orders of integration, and subsequently estimate the long-run and short-run elasticities of the variables. Using the NARDL dynamic framework developed by Shin *et. al.,* (2014), the study extends the

ARDL approach to model the short run and long run nonlinear relationships. The findings from the ARDL model show that FD and IND have a positive and significant effect on CO_2 emissions in the long run. In the short run however, only IND has a significantly positive effect on CO_2 emissions (at a 5 percent significance level). On the other hand, the findings from the NARDL model show that Positive variations in FD and IND have a significantly positive impact on CO_2 emissions, both in the short run and the long run (at a 1 percent significance level). On the other hand, a Negative variation in IND has significant effect in lowering the amount of CO_2 emissions both in the short run and long run (at a 1 percent). However, a negative variation in FD has an insignificant effect on CO_2 emissions in Uganda.

The study suggests the following policy recommendations:

- There is need to prioritize sustainable industrial expansion and development by focusing on implementing policies that promote sustainable and environmentally friendly industrial practices, encouraging industries to adopt cleaner technologies and energy sources.
- There is a need to re-think financial development with a lens of sustainability to consider incorporating environmental sustainability measures within financial regulations and encourage investments in low-carbon projects to offset the potential environmental impact of financial development.
- There is a need to prioritize sustainable urban planning in Uganda to manage population growth and infrastructure development effectively, minimizing the potential negative environmental consequences associated with rapid urbanization.
- There is a need to develop and encourage sustainable trade and climate policies in Uganda aligned with environmental sustainability goals, such as imposing carbon tariffs or providing incentives for low-carbon production and trade to mitigate the potential rise in carbon emissions associated with increased trade.

- Lastly, there is a need for policymakers and other development partners in Uganda continue pursuing strategies that prioritize green growth, innovation, and investments in low-carbon technologies to sustain economic growth while reducing carbon emissions.

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Cooperation countries. *J. Clean. Prod*, *228*, 533–543

Appendix

Table A.1: Pairwise Correlation Coefficient of the study variables

Variables	CE	FD	IND	TOPEN	GDP	URB
CE	1.000					
FD	0.934*	1.000				
IND	-0.461*	-0.425*	1.000			
TOPEN	0.502*	0.639*	-0.115	1.000		
GDP	-0.251	-0.158	0.688*	0.224	1.000	
URB	-0.460*	-0.573*	-0.093	-0.647*	-0.198	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Source: Authors' own construction.

Table A.2: Variance Inflation Factors (VIF) of the study variables

Variable	**VIF**	**1/VIF**
IND	2.768	0.361
FD	2.641	0.379
TOPEN	2.499	0.4
GDP	2.36	0.424
URB	2.246	0.445
Mean VIF	2.503	

Source: Authors' own construction.

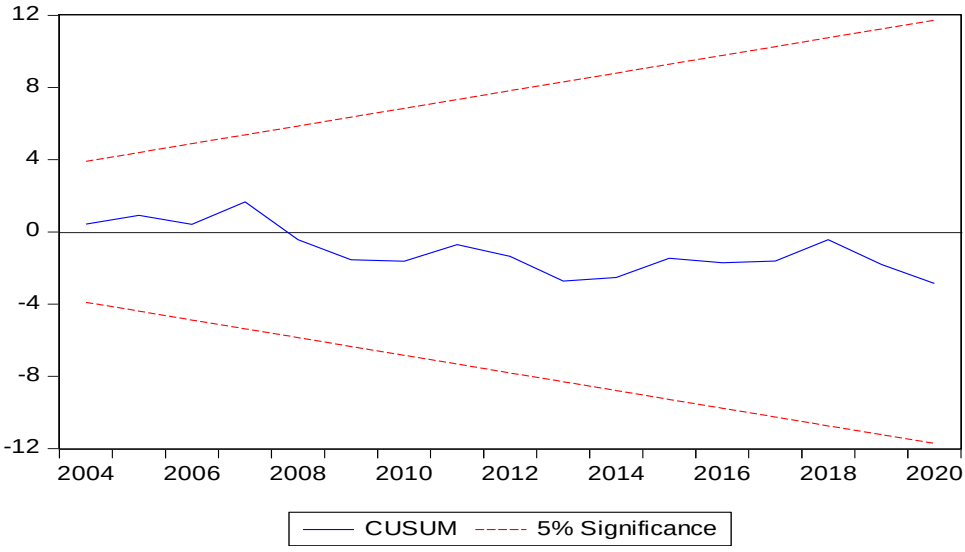

Figure A.1: Recursive Estimates for the CUSUM test

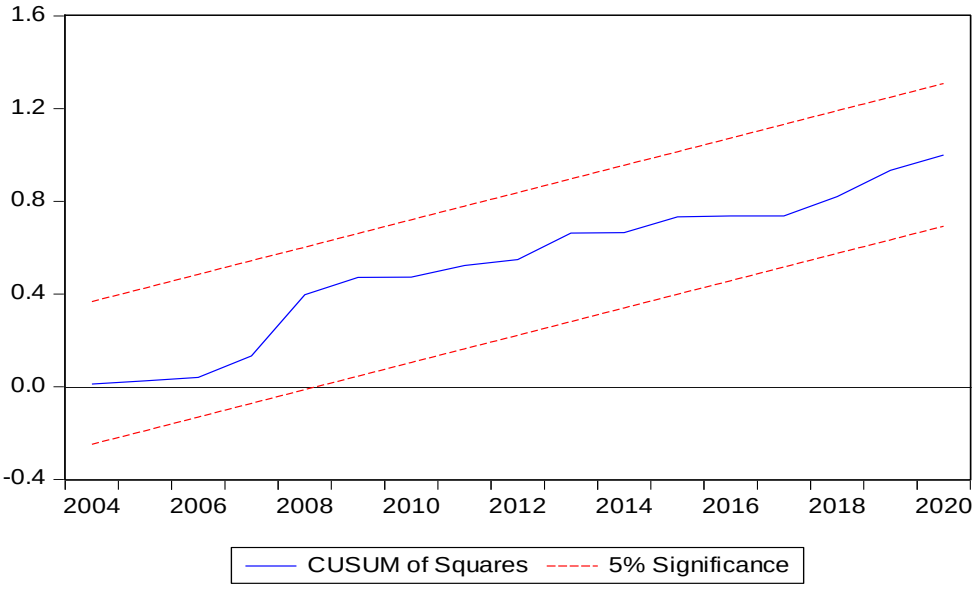

Figure A.2: Recursive Estimates for the CUSUM-Squared Test

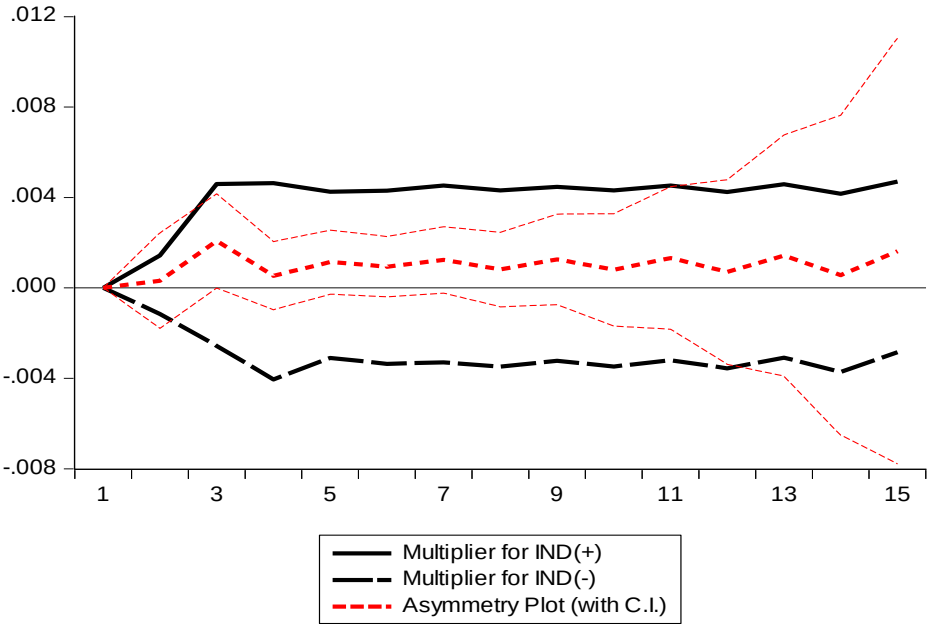

Figure A.3: Cumulative Dynamic Multiplier Changes of Industrialization on Carbon Emissions

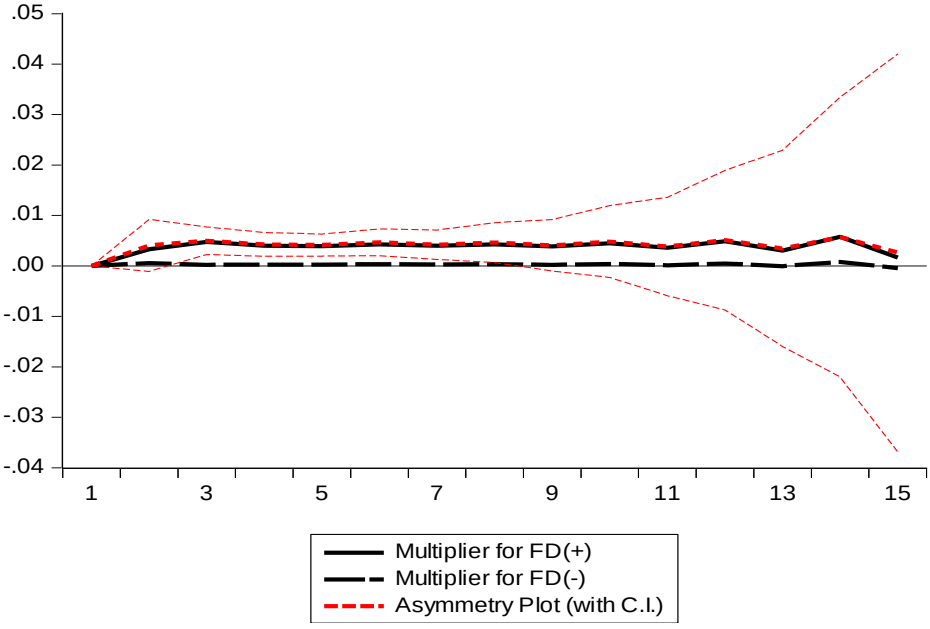

Figure A.4: Cumulative Dynamic Multiplier Changes of Financial Development on Carbon Emissions

CHAPTER 4

CLEAN ENERGY USE AND SUSTAINABLE DEVELOPMENT PARADOX: THE CASE OF CLEAN COOKING SOLUTIONS IN UGANDA

Ibrahim Mukisa[1]

Winnie Nabiddo[2]

Danstan Aguta[3]

Derrick Mbalule[4]

[1] School of Economics Makerere University, Kampala Uganda – Correspond Author
[2] National Planning Authority (NPA), Kampala Uganda
[3] Uganda Bureau of Statistics (UBOS), Kampala Uganda
[4] National Planning Authority (NPA), Kampala Uganda

1. INTRODUCTION

Amidst the intricate fabric of Uganda's development landscape, a compelling narrative of energy transformation, environmental rejuvenation, and public health enhancement has emerged. Emboldened by the third National Development Plan (2020/21-2024/25), the Ugandan Government's vision is a comprehensive reconfiguring of the country's cooking energy paradigm [4]. This transformative endeavour is characterised by a dual-fold ambition: to curtail the reliance on biomass consumption for cooking to a mere 50 percent by 2027 while simultaneously elevating the proportion of the populace adopting clean cooking solutions to a parallel 50 percent.

The far-reaching ramifications of this ambitious plan extend into numerous dimensions, encompassing environmental sustainability, public health improvement, and the economic empowerment of households. As Uganda positions itself on this transformative trajectory, the need for a thorough and incisive study becomes increasingly evident. Such a study holds the potential to unveil the intricate interplay between policy interventions, socio-economic dynamics, and behavioural responses that collectively determine the success or obstacles faced by these initiatives.

Central to the study is a comprehensive exploration of the multi-faceted incentives woven into the fabric of policy measures. These incentives encompass a spectrum of strategies, ranging from the strategic distribution of 1 million 13 kg Liquefied Petroleum Gas (LPG) cylinders between 2022 and 2025 to the judicious application of Value Added Tax (VAT) waivers on LPG and ethanol for cooking. Additionally, these incentives include the elimination of import duties on stove components required for local assembly, as well as the promotion of methane tubular digesters and solar panels for solar cooking. Implementing a lifeline tariff for electricity-based cooking and reducing import duties on stoves from 25% to 10% demonstrate the government's commitment. The policy further aspires to increase national LPG uptake from 1% to 8% on the energy balance and

increase per capita electricity consumption from 100 kWh in FY2018/19 to 578 kWh.

These strategic policy interventions were envisaged to shape household behaviours and choices significantly. However, the study reveals some nuanced complexities underlying these interventions' efficacy. By dissecting the influences of affordability, convenience, and socio-cultural factors, the research provides insights into how these policies resonate across diverse strata of society. The study assessed how reduced taxation and targeted distributions prompt the intended behavioural shifts, especially among economically disadvantaged households.

Moreover, the study explored consumer preferences, financial capacities, and perceptual dynamics that steer households' decisions to adopt clean cooking solutions. The study also illuminates the intricate interplay of factors that either accelerate or inhibit the transition towards cleaner energy options. By deciphering the rationale behind households' choices, the findings offer practical insights, enabling policymakers to tailor their strategies to better align with the needs and aspirations of the populace.

The broader canvas of the study is woven with threads that intertwine the envisioned transformation with international sustainability goals. As Uganda seeks to augment its forest cover and mitigate the adverse impacts of solid cooking fuels, the research highlights synchronising these endeavours with global benchmarks, particularly the United Nations Sustainable Development Goal (SDG) 7.1. This goal's vision of universal access to affordable, reliable, and modern energy services by 2030 resonates harmoniously with Uganda's aspirations.

2.0 Findings

2.1 Descriptive Findings

Adoption of Clean Energy for Cooking in Uganda

The national and international aspirations of economies are geared towards the broader spectrum of increasing clean energy uptake (cooking, lighting and heating). This paper, however, is centred mainly on clean energy for cooking, which is one of the fundamental aspirations of the country as enshrined in the third National Development Plan. The clean energy composition in the paper includes LPG/natural gas, Electric stoves (electricity, solar, generator, biogas), and kerosene stoves.

According to the findings in Table 1, only 3% of Ugandan households use clean energy for cooking. The findings demonstrate a significant variance in adoption by household factors. The gender of the household was found to be a significant determinant in the adoption of clean cooking solutions. Male-headed families (3%) were more likely to adopt clean energy for cooking than female-headed households (2%). Households with heads aged 30 or younger were more likely to utilise clean energy for cooking than older groups (16-30 years 3% and 31 years and older 2%).

Furthermore, research findings reveal that education level is essential to new technology uptake. Specifically, using clean energy for cooking increases with the household head's education level. Nine percent of homes with heads who have completed secondary school used clean energy for cooking, compared to less than one percent of households with no heads.

Table 1: Clean Energy Adoption by Household Characteristics

Household characteristics	Energy type	
	Unclean	Clean
Sex of head		
Male	97.4	2.6
Female	97.9	2.1
Age group of head		
16-30 Year	96.8	3.2
Over 30 Years	97.7	2.3

Education level of the head		
No Education	99.6	0.4
Primary	99.1	0.9
Secondary	96.9	3.1
Certificate And Above	91.0	9.0
Place of residence		
Rural	99.0	1.0
Urban	91.9	8.1
Region		
Kampala	82.2	17.8
Central	96.1	3.9
Eastern	99.3	0.7
Northern	99.4	0.6
Western	98.4	1.6
Household size		
Average size	5.4	4.0
Quantile Group		
1	99.5	0.5
2	99.2	0.8
3	98.5	1.5
4	97.2	2.8
5	93.8	6.2
Overall	**97.5**	**2.5**
Average annual income	**6,185,700**	**18,800,000**

Source: Energy for Rural Transformation III 2018, UBOS

Regional differences were noted in the household uptake of clean energy. Kampala city reported the highest proportion of households using clean energy for cooking (18%), and the least was reported in Northern and Eastern regions (less than 1%). The high update in Kampala could be explained by ease of access and the ability to afford associated acquisition costs. Households that adopted clean energy for cooking had an average size of 4 compared to 5.4 for households that use unclean energy. Household income is undoubtedly one of the critical factors for adopting clean energy, often manifested in the ability to pay for clean energy [1]. The results show that households that adopted clean energy for cooking have an average annual income of Ugandan shillings 18,800,000, compared to Ugandan shillings 6,185,700 for households that use unclean energy options. More households in urban areas (8%) adopted clean energy compared to rural areas (1%).

Access to Clean Energy for Cooking

The government has done a commendable job in extending electricity to the rural areas, one of the underserved areas through the Electricity for Rural Transformation (ERT 1, II, III) project. Despite the efforts, electricity access for lighting and cooking remains a significant challenge. The evidence presented in Table 2 is that 6 in every 10 households interviewed reported the grid being too far from the households as the main reason for not being connected to grid electricity. The cost of electricity remains a significant hindrance to household access to clean energy. Twenty-seven percent of the households cited this as the reason for their failure to access grid electricity, comprised of expensive initial connection fees (25%) and monthly fees (2%).

Table 2: Main Reasons Why Households Were not Connected to Grid Electricity

	Main reasons									
Household characteristics	**Grid Too far from household/not available**	**Cost of the initial connection is too expensive**	**Monthly fee is too expensive**	**Satisfied with the current energy solution**	**Renting, landlord decision**	**Services unreliable**	**Administrative procedure is too complicated**	**Submitted application and waiting for the connection**	**Company refused to connect the household**	**Others**
Residence										
Rural	66.3	23.5	1.8	0.6	1.7	2.4	0.9	0.9	0.2	1.6
Urban	37.1	38.1	3.4	1.4	11.0	1.0	2.0	1.6	0.0	4.3
Region										
Kampala	0.0	26.7	20.0	6.7	26.7	6.7	6.7	0.0	0.0	6.7
Central	66.7	20.0	4.0	0.9	4.7	0.6	0.8	1.0	0.1	1.3
Eastern	61.1	24.1	1.9	0.4	1.8	7.3	1.4	0.3	0.2	1.5
Northern	65.9	27.0	1.0	0.4	1.4	0.1	0.8	0.8	0.1	2.6
Western	60.3	28.7	1.0	1.0	2.7	1.0	1.0	1.8	0.3	2.2
Overall	63.1	25.1	1.9	0.7	2.7	2.3	1.0	1.0	0.2	1.9

Source: Energy for Rural Transformation III 2018, UBOS

Demand for Clean Energy for Cooking

The demand for clean energy exists, though some hindrances make this dream unattainable in the short run for several households. Respondents who were not using clean energy for cooking were asked whether they would be willing to purchase the clean energy options and by type of energy solution. The results in Table 3 show that traditional

manufactured stoves (39%), biomass stoves (34%), kerosene stoves (11%) and electric stoves (10%) were the 4 primary forms of cleaning cooking solutions households are most willing to pay for.

Table 3: Which Cook Stove Would You Be Most Willing to Purchase?

Background variables	**Kerosene**	**Bio Mass Stove**	**Manufactured Traditional Stove**	**LGP/Natural Gas Stove**	**Electric Stove**
Sex of head					
Male	11.7	33.7	36.9	6.8	11.0
Female	9.1	35.2	43.3	6.7	5.6
Education level of the head					
No Education	9.8	38.8	43.6	3.8	4.1
Primary	11.2	35.7	39.2	5.2	8.7
Secondary	13.0	27.9	33.0	11.0	15.1
Certificate and Above	7.7	25.2	35.4	16.1	15.7
Age group of head					
16-30 Year	15.9	27.8	36.6	5.7	14.0
Over 30 Years	10.0	35.3	39.0	6.9	8.7
Region					
Kampala	30.0	40.0	20.0	10.0	0.0
Central	13.4	20.6	45.2	10.5	10.3
Eastern	12.0	33.3	29.6	7.0	18.1
Northern	4.6	42.3	48.1	2.1	2.9
Western	12.3	40.2	35.4	6.5	5.6
Residence					
Rural	10.9	34.4	38.8	6.5	9.4
Urban	12.0	31.1	37.0	8.2	11.7
Quantile Group					
1	13.0	37.9	38.8	4.0	6.3
2	10.2	32.8	43.6	4.5	8.9
3	12.6	34.7	37.2	6.4	9.1
4	10.1	34.3	36.9	7.5	11.1
5	7.6	29.6	34.6	13.8	14.3
Overall	**11.0**	**34.2**	**38.5**	**6.7**	**9.6**
Mean annual income	**3,710,000**	**4,434,500**	**3,965,200**	**7,557,200**	**6,044,100**

Source: Energy for Rural Transformation III 2018, UBOS

The households willing to pay for clean energy were further presented with options for paying for their preferred energy solution in instalments instead of a one-off payment, which is often a challenge, especially for households facing financial stress. The results show that more than 50 percent of the household would pay for the clean energy of their choice if given up to two years (24 months) to complete the energy solution instead of paying for it once or within 6 months. Also noted in the results is that eight in ten households that desire kerosene stoves can pay for it if given 6 months, which is different from the other types of clean energy. This could be explained by the cost of acquiring a kerosene stove is much lower than other clean cooking solutions.

Table 4: Clean Energy Payment Options

Period of payment	Kerosene stove	Bio Mass Stove	Manufactured Traditional Stove	LGP /Natural Gas Stove	Electric Stove
Willingness to pay if given 6 months					
Yes	81.2	80.7	46.9	42.1	19.5
No	18.8	19.3	53.1	57.9	80.5
Willingness to pay if given 12 months					
Yes	68.4	76.0	59.8	60.8	29.6
No	31.6	23.6	40.1	39.2	70.4
Don't Know	0.0	0.4	0.1	0.0	0.0
Willingness to pay if given 24 months					
Yes	76.3	86.0	75.9	85.3	59.5
No	22.4	14.0	24.1	14.7	40.5
Don't Know	1.3	0.0	0.0	0.0	0.0

Source: Energy for Rural Transformation III 2018, UBOS

Availabilities of Clean Energy Solutions in Communities

Respondents were asked whether the different clean energy solutions were readily available within the last 12 months. Eighty-four percent of the households reported in the affirmative (always 64% and primarily available 20%). The northern region reported the highest

proportion of households where clean energy solutions are not readily available (33%), and the least was reported in the western region (8%).

Table 5: Availability of Clean Energy Solutions

Household characteristics	Always Available	Mostly Available	Sometimes Available
Urban			
Rural	75.9	13.0	11.1
Urban	58.2	22.7	16.4
Region			
Kampala	48.1	34.6	15.4
Central	77.6	7.5	14.9
Eastern	40.0	30.0	30.0
Northern	55.6	11.1	22.2
Western	73.1	19.2	3.8
Overall	**64.0**	**19.5**	**14.6**

Source: Energy for Rural Transformation III 2018, UBOS

Knowledge of the use of Improved Stove

The decision to adopt clean energy solutions could be informed by the benefits associated with using it or its ability to operate it. The respondents were asked if they had any knowledge or training on how to use the various clean cooking options. According to Table 6, 91 percent of families had no information or training on how to use renewable energy alternatives. Electric stoves (60%) and LPG/natural gas stoves (52%) had the highest rates of instruction or information on their use. This discrepancy in the knowledge about using various renewable energy options could be attributed to the complexity of each solution.

Table 6: Whether Received Training or Information on Improved Stove Use?

Type of cook stove	Yes	No
Biomass (Charcoal, Wood, Crop Residue, Etc.) Manufactured Stove	6.5	93.5
LGP/Natural Gas Stove	51.8	48.2
Kerosene Stove	18.3	81.7
Electric Stove	60	40
Overall	**9.5**	**90.5**

Source: Energy for Rural Transformation III 2018, UBOS

Social Costs Associated with the Use of Improved Cook Stoves

Using clean energy solutions often has negative consequences that deter other households from adopting them. The study profiled the users' experiences of clean energy solutions to understand cases of injuries or accidents and the causes of the incidence. The most severe incidence reported was death or permanent damage arising from carelessness/ error (83%), followed by burns/fire/poisoning also arising from carelessness (69%). On the other hand, 78 percent of the respondents reported cases of severe cough/respiratory problems that were considered to result from having a problem with the stove.

Table 7: Injuries/Accidents from Use of Improved Stoves by Cause

	Cause of injury accident	
Type of injury/accident	**Carelessness or error**	**Problem with the sto**
Death or permanent damage	83.3	16.7
Burns/fire/poisoning	68.7	30.0
Severe cough/respiratory problem	18.3	78.1
Other major injury	42.2	48.9
Minor injury	51.7	45.2
Fire with no injury	65.9	30.3
Itchy/watery eyes	25.9	64.9
Light cough	22.0	69.6

Source: Energy for Rural Transformation III 2018, UBOS

2.2 Empirical Findings

Factors Associated with Household's Adoption of Clean Energy for Cooking

A logistic regression was used to determine the factors associated with household's adoption of clean energy for cooking. Table 8 shows that the gender of the household is significantly connected with adopting a clean energy solution for cooking. Compared to female-headed households, male-headed households had higher probabilities of adoption (ORR =1.742, p=0.034). Regional disparities in adoption rates were also observed. Compared to the other four areas of Uganda, households in Kampala had a higher likelihood of adopting clean energy.

Households residing in urban areas were more likely to use clean energy than rural areas (ORR =1.957, p=0.022) [2]. Households with higher incomes had an increased chance to adopt clean energy solutions compared to those with lower incomes. Lower adoption was seen in households with many members compared to those with fewer household members (ORR=0.740, p=0.000). The availability of different clean energy solutions in the community was one of the critical factors for adoption [3] [5] [6]. The results show an increased odd for households adopting clean energy solutions, which reported that the clean energy solutions were readily available for all or most of the time.

Table 8: Determinants of Clean Energy Adoption among Households in Uganda

Adoption of clean energy	**Odds Ratio**	**P>z**	**[95% Conf. Interval]**	
Sex of head				
Female	1.000			
Male	1.742	0.034	1.041	2.913
Age group				
30 years and below	1.000			
Over 30 years	0.980	0.949	0.525	1.830
Region				
Kampala	1.000			
Central	0.540	0.018	0.324	0.901
Eastern	0.192	0.001	0.072	0.510
Northern	0.101	0.000	0.028	0.357
Western	0.374	0.004	0.191	0.731
Residence				
Rural	1.000			
Urban	1.957	0.022	1.102	3.474
Income	1.000	0.785	1.000	1.000
Household size	0.740	0.000	0.660	0.829
Availability of clean energy				

solution				
Always available	1.000			
Mostly available	1.650	0.066	0.967	2.813
Sometimes available	4.908	0.000	2.620	9.195
Rarely available	2.481	0.277	0.481	12.784
Constant	0.224	0.064	0.046	1.089

Source: Energy for Rural Transformation III 2018, UBOS

Conclusion and Recommendation

In conclusion, the chapter discussed the different factors associated with adopting clean energy solutions for cooking among households in Uganda. We utilised a logistic model and rich Energy for Rural Transformation III data collected in 2018 by the Uganda Bureau of Statistics (UBOS). Our findings indicate that the sex of the household head, place of residence, region where the household is located, household income level, and availability of energy solutions in the community were associated with adopting clean energy for cooking in Uganda. Therefore, the number of policy recommendations is prudent arising from the findings.

i. Using clean energy sources is crucial for mitigating climate change and reducing environmental pollution. Sensitisation efforts can significantly encourage individuals, businesses, and governments to adopt clean energy practices. Critical recommendations for sensitisation on the use of clean energy include education and awareness campaigns, promotion of financial incentives, community engagement, partnerships and collaborations, online and social media presence, energy audits, demonstration projects, policy advocacy, and celebrating clean energy success stories.
ii. Enhance income improvement to boost demand for clean energy for cooking, especially for households in rural areas, since its usage is associated with higher incomes.

iii. Improve availability and access to clean energy options for households in rural areas and regions is needed to address the unavailability of energy solutions for the households that need them.

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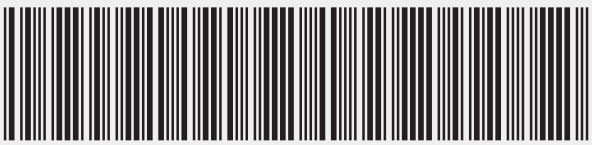

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