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Assessing the impact of sectoral demand on environmental sustainability in Nigeria: An input-output analysis

Mfonobong Okokon Effiong[1*], Manoj Panicker[2]

[1]*Department of Economics and Business Sciences Faculty of Economic and Financial Services Walter Sisulu University, Mthatha, South Africa.*
[2]*Faculty of Economic and Financial Sciences, The Executive Dean's Office, Walter Sisulu University, Zamukulungisa Campus, Private Bag X1, Mthatha, South Africa.*

Corresponding author: Mfonobong Okokon Effiong (*Email: meffiong@wsu.ac.za*)

Abstract

This study examines the relationship between sectoral demand and environmental sustainability in Nigeria using an input-output (I-O) analysis. Data were obtained from the Eurostat database. Results show that the fishing and mining sectors have the highest total effects and distributive effects on CO2eq emissions, indicating a high level of dependence on changes in sectoral consumption. The agricultural sector also has a significant impact on emissions, with a total effect of 0.0408 and a distributive effect of 0.0398. The study also analyzes output multipliers, income multipliers, and total income multipliers to understand the relationships between sectoral demand and economic growth. The results indicate that investing in sectors with high multipliers, such as mining and agriculture, can drive growth but also necessitate careful management to mitigate environmental impacts. The study suggests the need to adopt sustainable practices in key sectors to balance economic growth with environmental sustainability. Practical implications like developing policies and strategies to promote sustainable development in key sectors, investing in cleaner technologies and renewable energy to reduce emissions, promoting sustainable agriculture practices to reduce emissions and promote food security as well, and developing programs to educate and train stakeholders on sustainable development practices were identified for policymakers and practitioners.

Keywords: CO_2-eq emissions, Environmental sustainability, Input-output analysis, Nigeria, Sectoral demand.

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1. Introduction

Nigeria's economy is characterized by a high dependence on fossil fuels, which has led to environmental problems such as air and water pollution [1]. The country's environmental sustainability is further threatened by the lack of effective environmental regulations and inadequate waste management practices [2]. In this context, understanding the impact of sectoral demand on environmental sustainability is crucial for developing effective strategies to mitigate environmental degradation. Carbon dioxide equivalent (CO_2eq) emission has a crucial value for carbon management and sustainability purposes. It is used as a standard for measuring carbon footprint so we can compare the impact of greenhouse gases and measure them in terms of how much CO_2 will cause an equal amount of warming. Input-output (I-O) analysis is a central tool for analyzing inter-industry relations in a multisectoral economy such as Nigeria. This analysis allows insight into the distribution of products and services across sectors and an understanding of their economic relations and patterns [3]. When it comes to the sustainability of the environment, the quantification of greenhouse gas (GHG) is significant since GHG is accountable for the climate change impacts that affect the environment and the health of people.

CO_2e is a metric that represents the amount of greenhouse gases (GHGs) emitted by an activity or process, expressed in terms of the amount of carbon dioxide (CO_2) that would have the same global warming potential (GWP) [4]. CO_2e emissions are widely used as a measure of environmental sustainability because they:

- Account for multiple greenhouse gases: CO_2e emissions consider not only CO_2 but also other GHGs like methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (F-gases).
- Provide a common metric: CO_2e emissions offer a standardized unit of measurement, allowing for easy comparison and aggregation of emissions from different sources and activities.
- Reflect the impact on climate change: CO_2e emissions are directly linked to climate change, as they contribute to the increase in global temperatures [5].

In Nigeria, the major greenhouse gases are usually measured using carbon dioxide equivalent (CO_2eq), which is the total amount of carbon dioxide that would be produced by another gas with the same amount of heat-trapping capacity as the full amount of many gases over time [6]. It has become important to look at the sources and trends of CO_2-eq emissions given the increasing global concern over climate change, bearing in mind that Nigeria is experiencing rapid economic growth and industrialization. Despite the growing concern about environmental sustainability in Nigeria, there is a lack of empirical research on the impact of sectoral demand on environmental sustainability. Most studies have focused on the impact of economic growth on environmental degradation without considering the specific role of sectoral demand [7]. This study aims to fill this research gap by conducting an input-output analysis of the impact of sectoral demand on environmental sustainability in Nigeria. As for previous studies using I-O analysis to examine the emission pattern of countries, many of them pay attention to Spain, Uruguay, China, Mexico, and so on; however, relatively few studies have focused on Nigeria [8]. This deficiency has undermined the need for research on the Nigerian economy to assess the impact of demand structure in disaggregated sectors on the overall emission and determine the sectoral sources of environmental sustainability.

2. Conceptual Framework

Input-output (I-O) analysis: This examines the interrelationships between different sectors of the economy and their impact on environmental sustainability [9]. The framework considers the direct and indirect effects of sectoral demand on environmental sustainability, including the impact of energy consumption, waste generation, and pollution In Nigeria, input-output analysis can be used to examine the interrelationships between different sectors of the economy, such as agriculture, manufacturing, and energy, and their impact on environmental sustainability. For example, the analysis can help to identify the direct and indirect effects of increased demand for agricultural products on energy consumption, waste generation, and pollution. However, I-O analysis comprised key components such as:

- Sectoral Interdependencies: The input-output analysis recognizes that different sectors of the economy are interdependent, with each sector relying on inputs from other sectors to produce its output [10].
- Environmental Impacts: The framework considers the environmental impacts of each sector, including energy consumption, waste generation, and pollution [11].
- Direct and Indirect Effects: The input-output analysis distinguishes between direct and indirect effects of sectoral demand on environmental sustainability. Direct effects refer to the immediate environmental impacts of a sector's production activities, while indirect effects refer to the environmental impacts of the inputs used by the sector [12].

3. Theoretical Framework

One of the major theories directly linked to this study is the Environmental Kuznets Curve (EKC) hypothesis, which suggests that there is an inverted U-shaped relationship between economic growth and environmental degradation [13]. The EKC hypothesis argues that as an economy grows, environmental degradation initially increases but eventually decreases as the economy reaches a certain level of development. However, in Nigeria, examining the relationship between sectoral demand and environmental sustainability by identifying the turning point at which increased demand for energy and industrial products begins to lead to decreased environmental degradation can be done using the EKC hypothesis. This hypothesis is subject to key assumptions such as:

- Initial Increase in Environmental Degradation: As an economy grows, environmental degradation initially increases due to increased industrial activity, energy consumption, and waste generation [14].

- Turning Point: As the economy reaches a certain level of development, environmental degradation begins to decrease due to increased environmental awareness, improved technologies, and stricter environmental regulations [15].
- Eventual Decrease in Environmental Degradation: At higher levels of economic development, environmental degradation decreases as the economy shifts towards cleaner technologies, renewable energy sources, and sustainable practices [16].

4. Methodology

4.1. Data Sources/Analysis

Data for the study were sourced from secondary sources and analyzed using the input-output matrix, and the model is as specified:

4.2. Model Specification

4.2.1. Input-Output Matrix Model

Let:

Z = Intermediate Consumption Matrix (n x n)
Y = Final Demand Matrix (n x m)
X = Total Output Matrix (n x 1)
A = Coefficient Matrix (n x n)
L = Leontief Inverse Matrix (n x n)
CO_2 = CO_2-eq emissions Matrix (n x 1)
TE = Total Effect Matrix (n x n)
DE = Distributive Effect Matrix (n x n)
OM = Output Multiplier Matrix (n x n)
IM = Income Multiplier Matrix (n x n)

$$X = (1 - A)^{-1}Y \quad \text{(Leontief Equation)} \quad (1)$$

$$CO2 = (TE \times Y) \quad \text{(Total Effect)} \quad (2)$$

$$CO2 = (DE \times Y) \quad \text{(Distributive Effect)} \quad (3)$$

$$OM = L \quad \text{(Output Multiplier)} \quad (4)$$

$$IM = L(I/VA) \quad \text{(Income Multiplier, where VA = Value Added)} \quad (5)$$

5. Results and Discussions

5.1. Sectoral Demand and Environmental Sustainability

The analysis presents critical insights into the relationship between sectoral final demand and CO_2-eq emissions in the context of environmental sustainability in Nigeria. Each sector's Total Effect (TE) and Distributive Effect (DE) values indicate how changes in demand influence overall emissions, shedding light on both direct and indirect environmental impacts.

Table 1.
Effect of sectoral demand emission (environmental sustainability).

I-O Sectors	Total effect (%)	Distributive effect (%)
Agriculture	0.0408	0.0398
Electrical and Machinery	0.0408	0.0391
Fishing	0.0409	0.0411
Re-export & Re-import	0.0638	0.0364
Petroleum, Chemical, and Non-Metallic Mineral Products	0.0488	0.0365
Mining and Quarrying	0.0425	0.0410
Financial Intermediation and Business Activities	0.0400	0.0342
Post and Telecommunications	0.0419	0.0352

As presented in Table 1, the sectors that contributed the highest in terms of total and distributive effects were fishing (TE: 0.0409, DE: 0.0411) and mining and quarrying (TE: 0.0425, DE: 0.0410). These sectors do not only respond to an upturn in demand with corresponding emissions but also suggest a relatively high level of dependence on changes in sectoral consumption. The fishing sector in particular has also been exposed to practices that enhance carbon emissions, hence the need to adopt sustainable fishing practices. Climate change has negative effects on the fishery subsector through flood, drought, rise of sea level in the Atlantic Ocean, and elevated water temperatures. Nonetheless, it is instructive to note that human activities also raise higher emissions in the Nigerian fishery sector. From the first half of 2014, safeguards, including prohibitive measures such as quotas on the import of fish, have reduced the nation’s dependency on imported fish by 25 % yearly [6]. This has led to the enhancement of pressure on the freshwater fisheries, most of which are carried by keystone small-boat operators and hand gear fishermen. As of today, the artisanal fishers contribute to 85% of the fisheries production since aquaculture has not greatly developed in Nigeria [7]. Research by Chatellier-Lorentzen and Sheinbaum-

Pardo [8] indicates that marine ecosystems, which provide protein for millions in poverty, will face substantial shifts in fish stocks and increased mortality due to rising temperatures.

The agricultural sector, with a Total Effect (TE) of 0.0408 and a Distributive Effect (DE) of 0.0398, plays a vital role in the economy. However, its emissions are sensitive to changes in final demand. To mitigate this, adopting techniques that reduce emissions without compromising food production is crucial. Specifically, a 1% increase in final demand for agriculture leads to a 0.040% rise in emissions, implying a worsening of the economy's CO_2eq emissions. This finding aligns with previous research and studies conducted in Spain.

Furthermore, if final demand across all sectors increases by 1%, agricultural sector emissions would rise by 0.0398% relative to previous total CO_2eq emissions. This translates to a 0.061% increase in emissions from the agricultural sector, consistent with findings in Spain. The petroleum, chemical, and non-metallic mineral products sectors (TE: 0.0488, DE: 0.0365) and electrical & machinery sectors (TE: 0.0408, DE: 0.0391) exhibit moderate total effects and slightly lower distributive effects. This suggests potential for emissions reductions through efficiency improvements and cleaner technologies adoption. These sectors are prime candidates for low-carbon initiatives to balance economic growth with environmental sustainability.

In contrast, the re-import and re-export sectors have the lowest impact on emissions (TE: 0.0635, DE: 0.0364), indicating minimal direct impact from demand changes. However, their DE remains relatively consistent, suggesting a stable but lower contribution to emissions. Sectors like post and telecommunications (TE: 0.0419, DE: 0.0352) and financial intermediation and business activities (TE: 0.0400, DE: 0.0341) display lower distributive effects.

Though their absolute levels of emission were high, they were comparatively less responsive to variation in final demand, which might be the area to tap for efficiency gains from digital technologies. Therefore, the time requires an admixed strategy of economic recovery and environmental protection and, more importantly, pushed by surging global climate change challenges. From this analysis, Nigeria can therefore strive for improvements in its resource productivity, aiming at a sustainable future that is still economically robust [9].

5.2. Output Multipliers

The total output multipliers offer an understanding of changes in demand in a specific sector of the Nigerian economy and its impact on the economy, including both direct and indirect effects.

Table 2.
Output multipliers.

Total Output Multipliers		
SECTOR	**Output multipliers**	
	Type I	**Type II**
Agriculture	1.758	2.411
Mining	2.118	2.890
Manufacturing	1.726	2.635
Service	1.803	2.412

From the analysis in Table 2, the agricultural sector has an output multiplier to total output of 2.411, meaning that for every incremental output in the agricultural sector, the whole economy output is expected to rise by 2.411 units. This is the total positive direct effect (1.758) and total positive indirect effect (0.653) attributed to the sector. This high multiplier indicates that agriculture is used to boost economic activity, which would be a significant boost to food security and support for livelihoods. The mining sector had the highest total output multiplier of 2.890, as seen on the list above. This implies that the expansion of mining output creates about three times the value of finished output in the economy. The high values of direct (2.118) and indirect (0.772) impacts remind us about mining as an important driver of economic development while at the same time posing questions about its environmental friendliness following the calculated CO_2-eq emissions. The manufacturing sector represents a total multiplier of 2.635, and it is closely linked with several other sectors. The direct impact (1.726) and the indirect effect (0.910) explain that manufacturing can respond to a demand to improve economic performance but also show the importance of sustainable manufacturing in reducing the destruction of the environment. Last but not least, the total output multiplier of the service sector is 2.412, which shows a quite high level of economic interaction. The direct coefficient (1.803) and the indirect one (0.609) indicate that demand fluctuations in service industries can be particularly useful for stimulating overall economic activity. This is particularly relevant in discussions about sustainable development, as service sectors typically have lower environmental footprints compared to more resource-intensive sectors [10].

Overall, these multipliers illustrate the interconnectedness of sectors within Nigeria's economy and underscore the importance of considering both economic growth and environmental sustainability in policy planning. Investing in sectors with high multipliers, such as mining and agriculture, can drive growth but also necessitates careful management to mitigate environmental impacts, ensuring that development aligns with sustainable practices [11].

5.3. Income Multipliers

The total income multipliers indicate the relationship between initial changes in sectoral output and the resultant changes in income throughout the Nigerian economy. Here's an interpretation of the results for each sector:

Table 3.
Income multipliers.

Total Income Multipliers		
Nigeria Input output		
SECTOR	**OUTPUT MULTIPLIERS**	
	TYPE I	**TYPE II**
Agriculture	1.769	2.540
Mining	2.222	3.190
Manufacturing	1.430	2.053
Service	2.178	3.127

The income multipliers for all the sectors are shown in Table 3. While the total income multiplier for agriculture was 2.540, this on balance shows that as the agricultural sector unlocks one unit of income, the total income within an economy is boosted by 2.540 units. The first-order income (0.141) is direct (0.053) and indirect (0.055), therefore, it emerged that agriculture has a very important role in increasing total income. This is a very vital area if the income of the rural people is to be boosted through the achievement of food security. The total income multiplier for the mining sector was 3.190 units – the largest of any sector, indicating that a unit rise in income within the mining sector produces approximately 3.190 units of total income in the economy. The direct and indirect control show that the sector can foster income growth, 0.087 and 0.074 respectively, which is imperative; however, the effects of mining which are precisive mandate sustainable practices. Consequently, with a total income multiplier of 2.053, the manufacturing business has a high potential to stimulate income change in the economy through direct (0.055) and indirect (0.049) effects. In this sector, opportunities available in demand for the product can considerably raise return on income that should be very strategic to provide capital and funds to support economic development while satisfying the sustainability problem of production processes. The service sector provided the smallest, though still markedly significant, measure of total income, with a total income multiplier of 3.127. This means that the service sector is capable of generating a large net income as a proportion of initial changes in output. The direct and indirect shares stress the part of the sector within income earning, which matters in another significant aspect in any debate over sustainable economic growth. As opposed to growth-intense impacts, service industries are comparatively less damaging than sectors that require vast quantities of raw materials [12]. According to A report from the African Growth Initiative, the mining and quarrying sector has been key in the development of the nation, contributing to about 70% of the GDP for the past five years.

With more than 600 mining companies operating in Nigeria, this sector is expected to have a considerable impact on emissions. Moreover, the pressure towards sustainable food production in Nigeria has produced a growth of home food production, both for intra-hold and commercialization purposes, through increasing the export wholesale trade. This aligns with the observation made by Lenzen [12] who observed that while the energy demanded for the wholesale sector in Mexico has improved incrementally, the total energy by this sector stood highest at nearly 0.0635%. Consequently, these income multipliers portray the involvement of the Nigerian economy in various sectors of income generation. Higher multicollinearity coefficients relating to such sectors as mining and services suggest the direction for focused investment to foster an increase in income. Although this growth must be encouraged, leaders must ensure a sustainable environment for long-term economic development and minimize the negative effects of ecology.

6. Conclusions and Policy Recommendations

In conclusion, this analysis highlights the intricate relationship between sectoral demand, economic growth, and environmental sustainability in Nigeria. The input-output (I-O) results suggest that sectors like fishing and mining have the largest total and distributive impacts on the CO_2eq emissions that are most sensitive to changes in the final demand. The fishing sector's operations have repercussions on carbon emissions and encourage sustainable practices to reduce the impact on the environment. Similarly, agriculture's emissions are directly tied to demand fluctuations, emphasizing the need for innovative approaches that balance food security with sustainability.

The output and income multipliers depict the interaction between sectors in the Nigerian economy. Mining and agriculture, being marked by relatively high multipliers, are expected to have the ability to stimulate increased additional economic activity and incomes, although these are likely to arrive hand in hand with increasing environmental degradation. Consequently, the results presented herein imply that investments in these sectors need to be accompanied by activities that focus on emissions mitigation and sustainability improvements.

Overall, this study recommends a coherent policy regime that incorporates the principles of economic growth and sustainability. Given the rising climate exposures in Nigeria, applying knowledge from this analysis may help direct proper investments and activities that foster the development of the nation while preserving and enhancing the environment. In this way, Nigeria will be able to build economic resiliency and continue serving the country’s development of a sustainable environment. However, considering its implication on environmental sustainability, the results underscore the need to prioritize sectors with higher total and distributive effects for sustainability initiatives, through:

- Targeted interventions: More specifically, there are industries in sectors such as fishing, mining, and agriculture that emit high amounts of pollutants. In this case, measures may encompass the promotion of sustainability practices, improvement of resource use, and application of low-carbon technologies.
- Economic diversification: Cutting the dependency and promoting more sectors that contribute to less or no emissions could help bring about a better change in terms of economics.
- Policy development: To policymakers, these are important sectoral dynamics that need to be taken into account while designing rules and standards that will foster sustainability. Thus, Nigeria can use the focus on the priority sectors to achieve economic growth, which would also lead to environmental protection.
- Awareness and education: Increased concern with the environmental effects of different industries and encouraging responsibility for preserving the earth can build up a stronger economy, which in return enables development and conservation.

References

[1] A. O. Adeyemi, C. O., and M. O. Oluwatomisin, "CO2 emissions and environmental implications in Nigeria," *International Journal of Energy, Economics and Policy*, vol. 54, no. 1, pp. 34-43, 2020.

[2] J. O. Leke and E. N. Leke, "Environmental sustainability and development in Nigeria: Beyond the rhetoric of governance," *International Journal of Development and Management Review*, vol. 14, no. 1, pp. 25-37, 2019.

[3] V. Alcántara and E. Padilla, "Input-output subsystems and the relationship between energy consumption and GDP in Spain," *Applied Energy*, vol. 86, no. 9, pp. 1513-1521, 2009.

[4] V. Alcántara and E. Padilla, "Key" sectors in final energy consumption: An input–output application to the Spanish case," *Energy Policy*, vol. 31, no. 15, pp. 1673-1678, 2003.

[5] V. Alcántara and E. Padilla, "Key sectors in greenhouse gas emissions in Spain: An alternative input–output analysis," *Journal of Industrial Ecology*, vol. 24, no. 3, pp. 577-588, 2020. https://doi.org/10.1111/jiec.12948

[6] B. Bocoum, *The mineral and energy sectors and stages of economic development: A comparative input-output analysis*. Abidjan: African Development Bank, 2000.

[7] A. A. Ogundipe, S. A. Ogunwande, and O. O. Ajayi, "Economic growth and environmental degradation in Nigeria: An empirical analysis," *Journal of Environmental Economics*, vol. 7, no. 1, pp. 1-12, 2018.

[8] D. Chatellier-Lorentzen and C. Sheinbaum-Pardo, "Assessing the impacts of final demand on CO2-eq emissions in the mexican economy: An input-output analysis," *Energy and Power Engineering*, vol. 9, no. 1, pp. 40-54, 2017. https://doi.org/10.4236/epe.2017.91004

[9] W. Leontief, "Environmental repercussions and the economic structure: An input-output approach," *Review of Economics and Statistics*, vol. 52, no. 3, pp. 262-271, 1970.

[10] R. E. Miller and P. D. Blair, *Input-output analysis: Foundations and extensions*. Cambridge, UK: Cambridge University Press, 2009.

[11] E. Dietzenbacher and B. Los, "Structural decomposition analyses with dependent determinants," *Economic Systems Research*, vol. 12, no. 4, pp. 497-514, 2000. https://doi.org/10.1080/09535310020003793

[12] M. Lenzen, "A generalized input-output multiplier calculus for Australia," *Economic Systems Research*, vol. 13, no. 1, pp. 65-92, 2001. https://doi.org/10.1080/09535310120026256

[13] G. M. Grossman and A. B. Krueger, "Economic growth and the environment," *The Quarterly Journal of Economics*, vol. 110, no. 2, pp. 353-377, 1995. https://doi.org/10.2307/2118443

[14] D. I. Stern, "The rise and fall of the environmental kuznets curve," *World Development*, vol. 32, no. 8, pp. 1419-1439, 2004. https://doi.org/10.1016/j.worlddev.2004.03.004

[15] S. Dinda, "Environmental kuznets curve hypothesis: A survey," *Ecological Economics*, vol. 49, no. 4, pp. 431-455, 2004. https://doi.org/10.1016/j.ecolecon.2004.02.011

[16] T. Panayotou, "Empirical tests and policy analysis of environmental degradation at different stages of economic development," Working Paper WP238, Technology and Employment Programme, International Labour Office, 1993.

Appendix

Tables

Total and distributive effects

I-O Sectors	Total effect	Distributive effect
Agriculture	0.0408	0.0398
Electrical and Machinery	0.0408	0.0391
Fishing	0.0409	0.0411
Re-export & Re-import	0.0638	0.0364
Petroleum, Chemical, and Non-Metallic Mineral Products	0.0488	0.0365
Mining and Quarrying	0.0425	0.0410
Financial Intermediation and Business Activities	0.0400	0.0342
Post and Telecommunications	0.0419	0.0352

Output and Income Multipliers by Sector

Total Output Multipliers

Nigeria Input output

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SECTOR INITIAL FIRST INDUSTRY TOTAL CONSUMER TOTAL TYPE I TYPE II

Agric	1.000	0.383	0.376	1.758	0.653	2.411	1.758	2.411
Mining	1.000	0.613	0.505	2.118	0.772	2.890	2.118	2.890
Manufacturer	1.000	0.399	0.326	1.726	0.910	2.635	1.726	2.635
Service	1.000	0.440	0.363	1.803	0.609	2.412	1.803	2.412

TOTAL INCOME MULTIPLIERS

Nigeria Input output

SECTOR	INITIAL	FIRST	INDUSTRY	TOTAL	CONSUMER	TOTAL	TYPE I	TYPE II
Agric	0.141	0.053	0.055	0.249	0.109	0.357	1.769	2.540
Mining	0.133	0.087	0.074	0.294	0.128	0.423	2.222	3.190
Manufacturer	0.243	0.055	0.049	0.347	0.151	0.498	1.430	2.053
Service	0.107	0.072	0.053	0.232	0.101	0.334	2.178	3.127

NB: Type 1 considers only the intermediate sectors

Type 11 considers both the intermediate sectors and the final demand.