Innovations

Cost Implications of Oil Spillage on the Balance of Payments and Poverty Index in Nigeria (2006 – 2023)

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Abstract: *The study examined the cost implications of oil spillage on the balance of payment and poverty index in Nigeria (2006-2023). The specific objectives are to; determine the cost implications of oil spillage and balance of payment; and to ascertain the cost implications of oil spillage and on the poverty of people between 2006 - 2023. The study employs panel regression design. The study make use of secondary data procedures in determining the cost implications of oil spillage by major oil companies in Nigeria.The population of this study consists of 40 oil and gas companiesoperating in Nigeria from 2006 to 2023. These companies include both multinational corporations and indigenous firms engaged in the exploration, production, refining, and distribution of oil and gas resources.The data was analysed using linear regression with the application of the panel Least Squares (OLS) technique to test the hypotheses. The study shown that cost implications of oil spillage had a significant positive impact on the balance of payments, with a t-statistic of 0.110303 and a p-value of 0.0171, in Nigeria between 2006 and 2023. The cost implications of oil spillage have a significant impact on the poverty index with a t-statistic of -0.004232 and a p-value of 0.0018 in Nigeria from 2006 -2023.The study recommended among others that the Nigerian government should strengthen environmental regulations and strictly enforce penalties for oil spillage. Improved environmental governance will enhance Nigeria's attractiveness to foreign investors by promoting sustainability and reducing reputational risks associated with environmental degradation.*

Keywords: Oil spillage, balance of payment, poverty, inflation, Cost implication

JEL classification M48, L264, M16

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Conceptualization-N.C.V, R.O.U, O.W.O; Methodology-N.C.V, R.O.U; Writing-N.C.V, R.O.U and O.W.O; Investigation-N.C.V, R.O.U; Resources-N.C.V, R.O.U and O.W.O; Supervision-N.C.V and R.O.U

Introduction

Since the Industrial Revolution, when crude oil was discovered, there have been oil spills all over the world. An estimated 0.7–1.7 million metric tonnes of petroleum are released into rivers, seas, and oceans annually because of human activity (www.science.irank.org). The environment in oil-producing regions has been seriously threatened by oil leaks, which, if left unchecked, might destroy entire ecosystems. According to Nwuba (2018), the Niger Delta is one of the world's ten most significant marine and wetland ecosystems. It is undeniable that the region's oil industry has made a significant contribution to the nation's growth and development, but irresponsible oil exploration has left the Niger Delta region among the five most severely damaged ecosystems in the world due to petroleum use. The Niger Delta in Nigeria's town of Oloibiri yielded crude oil discoveries in 1956 for Shell British Petroleum (now Royal Dutch Shell) (Anifowose, 2008). Commercial production of crude oil started in 1958. One thousand four hundred and eighty-one (1,481) wells and fifty-nine (159) oil fields are being operated by eleven (11) oil corporations in Nigeria's Niger Delta. Several significant environmental issues are brought about by human activity, including the exploration and exploitation of oil, the loss of biodiversity, erosion of coastal and riverbanks, flooding, oil spills, gas flaring, noise pollution, sewage and wastewater pollution, land degradation, loss of soil fertility, and deforestation. In the Niger Delta, oil has been explored and exploited for several decades. Both the local population and the ecosystem in the area have suffered greatly as a result of it. There are roughly 123 gas-flaring sites in the Niger Delta region, according to estimates from the Energetic Solution Conference (Anifowose, 2008)

Between 2006 and 2015, NOSDRA documented 385,334.74 barrels of oil spillage. The numbers are conservative because it seems challenging to determine the precise amount of spill at each given incidence.

Statement of the Problem

The oil exploration and exploitation has led to a great deal of environmental deterioration in the Niger Delta region. This is true even though the government has taken steps to stop oil spillage by 2008 and there are monitoring organisations, laws, and standards in place.

Nwuba's (2018) research on the financial implications of oil spills in Nigeria revealed that these activities have a noteworthy yet adverse impact on the country's economy. The study's conclusions also showed how important gas flaring and oil spills are in terms of both their quantity and cost. These results suggest that, given that oil spills have been generally increasing over time, Nigeria's ability to grow has been somewhat jeopardised. The study also concluded—based on the findings—that different policies intended to regulate the oil and gas quagmires have not been adequately implemented. Similarly, the following conclusions were drawn from Ozabor and

Numerous studies have been carried out in this field, such as Ugboma's (2015) study on the need for sustainable development in the oil-producing regions of Nigeria's Niger Delta; environmental deterioration; Syed and Yeasin (2017) on the issue of oil spills and potential solutions; Nigerian oil spill victims' compensation varies according to the amount of oil spilt. Environmental pollution in oil-producing regions of Nigeria's Niger Delta Basin: An empirical evaluation of trends and public perception, Ndubuisi and Asia, 2007 In Nwuba's (2018) analysis of the financial effects of oil spills in Nigeria from 2006 to 2015, the main emphasis was on the amount, magnitude, and cost of these events. This studyexamines the costs associated with oil spills by oil companies in Nigeria on balance of payments and poverty index between 2006 and 2023.

Objectives of the study

The study's general objective is to evaluate the cost implications of oil spillage and by oil companies in Nigeria on the Nigerian economy between 2006 and 2023. The specific objectives to:

1. determine the cost implications of oil spillage on balance of payment between 2006 and 2023.
2. ascertain the cost implications of oil spillage on the poverty rate in Nigeria between 2006 and 2023.

The following research questions are in line with the specific objectives of the study:

1. To what extent do thecost implications of oil spillage in Nigeria impacted balance of payment (POB) between 2006 and 2023?
2. How has the cost implications of oil spillagein Nigeria affected on the poverty rate between 2006 and 2023?

Statement of the Hypotheses

The following hypotheses formulated in the null forms are in line with the specific objectives of the study:

1. The cost implications of oil spillage have no significant positive impact on balance of payment (BOP) in Nigeria between 2006 and 2023.
2. The cost implications of oil spillage have no significant positive impact on the poverty rate in Nigeria between 2006 and 2023.

Review of Related Literature

The balance of payment is a report detailing a country's international transactions for a specific time frame (Lagoarde, Segot, 2023). According to Imoisi (2012), a country's trading position and foreign financial transactions are documented in its balance of payments. In the field of international economics, the notion of balance of payments (BOP) is crucial. All a country's monetary dealings with other countries are documented in it. The current account and the capital account are the two primary components of it (Baghdady&Abdelsalem, 2024).

A record of all transactions about income, products and services traded, and current transfers is the current account. Everything from the purchase and sale of products and services to the receipt and disbursement of monetary funds from sources such as rent, dividends, interest, and more falls under this category.

If more money is flowing into the country, the balance of payments (BOP) will be in surplus. If more money is flowing out, the BOP will be in deficit. The value of a country's currency and its stock of foreign currency reserves can both drop if its balance of payments is negative (Lioudis, 2022).

According to Ukoli (2005), economic growth is associated with enhancing people's quality of life through improving packaged goods and services, reducing risk, and fostering innovation and entrepreneurship. This is achieved using recent technological developments and improvements in infrastructure. The primary goal of economic development, according to Afuberoh and Okoye (2014), is to ensure that local communities and regions can produce goods in sufficient quantities to be exported to other countries, while also providing a favourable environment for businesses to thrive. In addition to indicators like water supply, transport networks, health, and education that can be usedto gauge economic development is a globally accepted metric for measuring long-term progress and the welfare of citizens (Grace David and Oliver, 2016).

Lack of needs is poverty in the broadest sense. Based on common ideals of human dignity, most people believe that basic needs including food, shelter, healthcare, and safety are essential (Bradshaw, 2007). Relative deprivation is the fundamental definition of poverty, according to

When a person's income or consumption falls below the poverty line, they are said to be poor. Accordingly, the poverty line serves as a threshold for dividing the impoverished from the "non-poor" (Bradshaw, 2007). Nonetheless, poverty typically combines aspects related to income and non-income. According to academics, the impoverished, for instance, are people who are unable to own property, find steady employment, make ends meet, or maintain a healthy lifestyle. They are also unable to meet their basic health needs and have an inadequate level of education (Blank, 2003.

Baghdady and Abdelsalam (2024) conducted a study to detect and analyze comprehensively the occurrence of oil spillpatterns and characteristics in the Eastern Mediterranean,North coast of Egypt over a decade (2014–2023). The study aims to analyze the critical role of remote sensing technologies in addressing environmental challenges caused by the maritime transport sector, advocating for enhanced monitoring and regulatory enforcement to protect marine ecosystems and support sustainable naval activities. The automated detection algorithms within the Sentinel application platform (SNAP) and integration with GIS mapping. The results revealed an increase in oil spill incidents within the Exclusive Economic Zone (EEZ), obviously drifting to the coastline and around major ports causing hindrances to economic activities in the area.

Methodology

Independent Variable

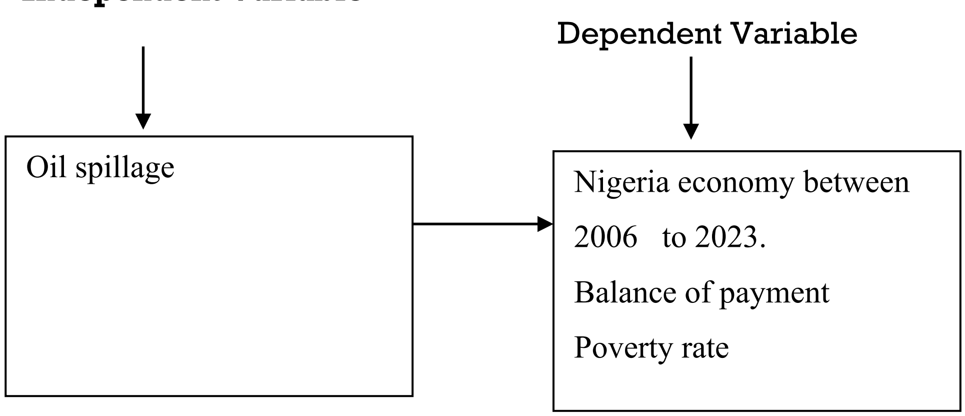

Figure 1: A Proposed Conceptual Model Showing the Cost Implications of Oil spillage by Oil Companies on Nigeria's Economy between 2006 to 2023.

Source: Adopted from Field Survey, 2023.

The proposed conceptual framework in Figure1, above proposes the following interrelationships: Oil spillageare used as an independent variable with economic development (gross domestic product (GDP), balance of payment and poverty index) as the dependent variable.

This study employs a panel research design, which involves examining data collected over multiple times for the same subjects, allowing for a comprehensive analysis of how variables change over time. The panel research design is ideal for studying the economic cost implications of oil spillage in Nigeria because it allows for a longitudinal analysis of how these environmental issues evolve over time. By collecting data repeatedly from the same entities, such as oil companies or regions, this design enables the tracking of changes in key variables, such as cleanup costs, healthcare expenditures, and environmental degradation, over multiple years. This approach is crucial for understanding the long-term economic impacts of oil-related environmental damage and identifying trends that would be missed in cross-sectional studies.A major advantage of the panel design is its ability to control unobserved heterogeneity, which refers to the constant factors that vary between entities but do not change over time, such as geographical characteristics or company-specific policies. By using models like fixed effects, the panel design can isolate the impact of oil spillage while controlling for these constant differences. This results in more accurate estimates of the direct relationship between environmental damage and economic outcomes, ensuring that the analysis focuses on time-varying factors like the frequency of oil spills.

Additionally, the combination of time-series and cross-sectional data in panel research allows for a comprehensive analysis of both temporal and spatial variations in the data. Researchers can observe how oil spillageaffect different regions or companies over time and identify whether certain areas are more vulnerable to environmental damage. This dual perspective is important for understanding the broader economic implications of oil production activities and for designing policies that address region-specific challenges. Finally, the dynamic nature of panel data facilitates the study of causal relationships and lagged effects, making it possible to assess how environmental degradation in one year affects economic indicators in subsequent years. This is essential for drawing stronger causal inferences and for providing policymakers with reliable data on the long-term effects of oil spillage. The panel design's ability to handle missing data and its capacity to model both immediate and delayed impacts further strengthen its suitability for this research, leading to more effective policy recommendations.

The researcher while conducting this study used purposive and convenient sampling techniques. Purposive sampling was used to select the fifty oil companies

while convenience sampling was used to select the required sample based on availability of data in interest.
This study anchored on 40 firms out of 50 major oil companies in Nigeria and their corresponding oil spillages and gas flared covering the period 2006-2023.
For this study, purposive and convenient sampling techniques are appropriate due to the specific nature of the research. Purposive samplingwas used to deliberately select the 50 major oil companies in Nigeria, focusing on those with significant operations related to oil spillage and gas flaring. This method ensures that the sample includes only companies relevant to the study's objectives, providing insight into the environmental and economic impacts of oil production activities. While convenient samplingis employed to select the final sample of 40 firms from the initial 50 based on the availability of dataon oil spillage between 2006 and 2023**.** This approach ensures that the study focuses on firms with reliable and accessible data, which is crucial for conducting an accurate analysis. This convenience sampling accommodates the challenge of data limitations while still providing a sufficient sample for the research.
By combining purposive and convenience sampling, this study ensures a targeted and practicalapproachto sampling. The purposive technique guarantees relevance by focusing on the most significant companies, while the convenience method addresses the availability of data. Together, these techniques provide a well-rounded sample for understanding the economic costs associated with oil spillage in Nigeria.

In conducting this study, data were meticulously sourced from both industry-specific financial statements and globally recognised databases to ensure the reliability and accuracy of the analysis. The primary variables of interest oil spillage, balance of payment and poverty rate were obtaineddirectly from the financial statements of oil and gas industries operating within Nigeria. These financial statements provide detailed and industry-specific data, offering insights into the environmental and economic activities directly associated with these industries.The study leveraged data from the World Bank's database indicators. The World Bank database is a reputable global source of comprehensive and up-to-date economic indicators, providing a broad perspective on macroeconomic variables. By combining data from these two sources, the study integrates detailed industry-specific insights with broader economic indicators, allowing for a more comprehensive analysis of the factors influencing the Nigerian economy. This multi-source approach ensures that the study is grounded in both detailed sectoral data and internationally recognised economic metrics. The data for this study covers a time period of 2006-2023.

The population of this study consists of 40 oil and gas companiesoperating in Nigeria from 2006 to 2023, which have been identified as key players in the oil and gas sector. These companies include both multinational corporations and indigenous firms engaged in the exploration, production, refining, and distribution of oil and gas resources. They are selected based on their significant roles in contributing to oil spillage activities, which have profound environmental and economic implications for the Nigerian economy.
Given the centrality of the oil and gas industry to Nigeria's economy, this study focuses on companies that have demonstrated substantial operational footprints within the Niger Delta region and other oil-producing areas. These companies are responsible for the majority of crude oil extraction and gas production, making them pivotal to understanding the cost implications ofenvironmental degradation, particularly oil spills, on both the local environment and the broader Nigerian economy. The selected population is representative of the wider oil and gas industry in Nigeria and provides the basis for a comprehensive examination of the financial, environmental, and social costs associated with the industry's activities over the 17-year period covered by the study. This population was chosen to ensure that the findings are relevant to policymakers, regulatory bodies, and stakeholders seeking to address the impacts of oil spillage on Nigeria's economic growth and sustainability.

Model Specification

Given that the numerical data applied to this study includes a combination of cross-sectional data and time series data, the model specification for this investigation was informed by the nature of the data. Cross-sectional data are data collected by observing many subjects (Oil and Gas) at the one point or period of time. While a time series data is a sequence of data point indexed in time order. These two data were combined to create panel data, which is what our data are. A panel data model can be roughly separated into static and dynamic panel models. The main distinction between the two is that the latter includes the lagged dependent variable as a regressor. The static panel data models, however, are the main emphasis of this work.

Specification of this model will allow us to evaluate the cost implications of oil spillage by oil companies in Nigeria on the Nigerian economy between 2006 and 2023. Assuming Y_{it} to be the dependent variable and the determinants given as X_{it}, a simple model of financial performance can be started as follows

$$\mathrm{Y_{it}} = \alpha + \sum_{k=1}^{j} \beta_k \mathrm{X_{kit}} + \mathrm{u_{it}}; \quad k = 1, \dots, J \dots \dots \dots \dots (1)$$

Where Y is the dependent variable and X_{it} are the explanatory variables. The subscripts i and t as defined earlier refer to cross sectional dimension and time dimension respectively. $u_{it}$is the composite error term which can be decomposed further into specific effects and remainder disturbance term. Henceforth, we will refer to i as the individual observation, which of course may imply firms, countries or any group of units. There are two sets of specific effects, namely the individual specific effects and time effects. If only one set of specific effects is included in the regression, such is referred to as a one-way error component model. Equations (2) and (3) shows decomposition of u_{it} into one way and two-way error components.

$$\mathrm{u_{it}} = \varphi_{\mathrm{i}} + \varepsilon_{\mathrm{it}} \dots \dots \dots \dots \dots \dots . (2)$$

$$\mathrm{u_{it}} = \emptyset_{\mathrm{t}} + \varepsilon_{\mathrm{it}}$$

$$\mathrm{u_{it}} = \varphi_{\mathrm{i}} + \emptyset_{\mathrm{t}} + \varepsilon_{\mathrm{it}} \dots \dots \dots \dots \dots \dots . (3)$$

Where φ_i and $\emptyset_t$ denote the unobserved individual and time specific effects respectively. We shall limit our empirical applications to a one-way error component.

Basically, the static panel data models can be estimated using Ordinary least squares (OLS), Fixed Effect (FE) and Random effect (RE). Baltagi, B. H., & Li, D. (2018). Each of these methods has its underlying assumptions which must be necessary to obtain unbiased and efficient estimates. However, for the purpose of this study we are going to employ the random and fixed effect models and then make our final selection of the best model using the Hausman test.

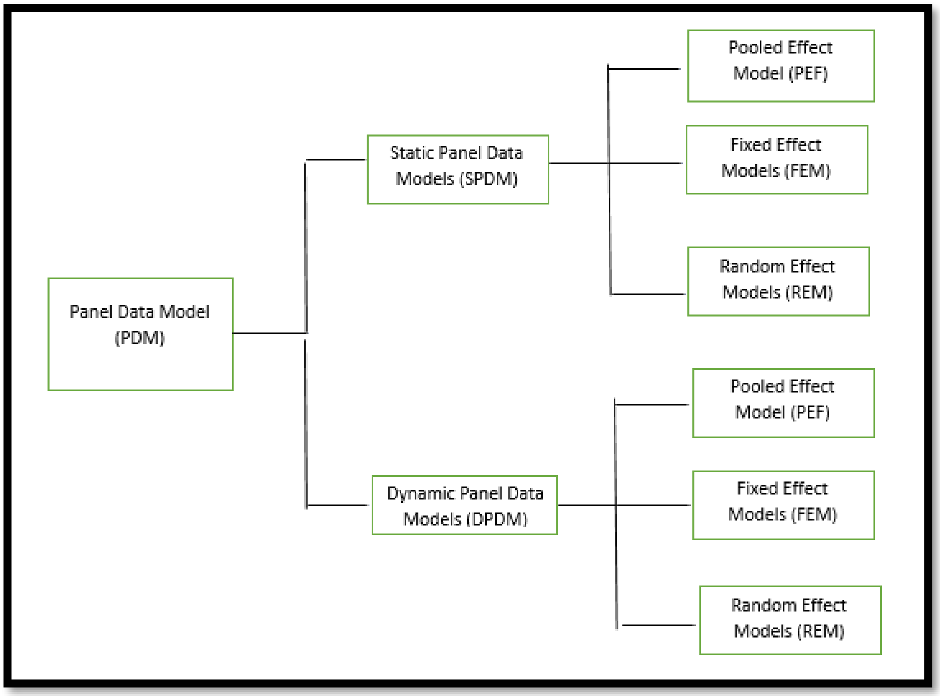

Fig 2: Panel Data Models

For the purpose of this study, our interest shall be on fixed and random effect.
The fixed effect (FE) regression is one method for capturing individual effects in a panel data model. Consequently, depending on the particular effect being taken into account, equation (1) is changed using either of the error components equations (2 or 3). The fixed effect approach is predicated on the notion that effects are estimable fixed parameters (Wooldridge, J. M. 2020). As a result, a variety of economic issues could arise, including

i. The unobserved specific effect may be correlated with the regressors employed.
ii. Some of the regressors may be correlated with the remainder disturbances that affect the dependent variable

The fixed effect approach can overcome this problem by using any of the three-method estimation namely, within Group Estimator, least Square Dummy variable estimator and first Difference estimator.
We provide below the specification in respect of these estimation techniques for fixed effects.

Within Regression: $Y_{it} - \overline{Y}_{i.} = \sum_{k=j}^{j} \beta_k (X_{kit} - \overline{X}_{ki.}) + \varepsilon_{it} - \varepsilon_{i.}\ ;\ k = 1, \dots, j$………………… (4)

First Difference: $Y_{it} - \overline{Y}_{it-1} = \sum_{k=j}^{j} \beta_k (X_{kit} - \overline{X}_{it-1}) + \varepsilon_{it} - \varepsilon_{it-1}$……………………… (5)

LSDV Regression: $Y_{it} = \sum_{k=j}^{j} \beta_k X_{kit} + \sum_{i=2}^{N} \gamma_i \Gamma_i \, \varepsilon_{it}$............................ (6)

To confirm whether the specific effects estimated are actually fixed effects, the F-test is used in this regard.

When there are too many factors to estimate due to large cross-sectional units, fixed effect regression typically suffers from a considerable loss of degree of freedom, which is one of its fundamental disadvantages (Lee, M., & Kim, J. 2020). If the cross-sectional units can be believed to be random, this significant loss of degree of freedom can be avoided. All of the regressorsare assumedexogenous by the random effect models. Given is the random effects regression:

$$Y_{it} - \emptyset \overline{Y}_{i.} = \sum_{n=1}^{m} \beta_n (X_{nit} - \overline{\emptyset X}_{ni.}) + \varepsilon_{it} - \emptyset \overline{\varepsilon}_{i.} \quad \ldots\ldots(7)$$

Where $\emptyset = 1 - \frac{\sigma_\varepsilon^2}{T\sigma_\mu^2 + \sigma_\varepsilon^2}$. If there are no random effects, then $\sigma_\mu^2 = 0$ and therefore $\emptyset = 0$.

We do the Hausman test to determine whether the individual effects calculated are indeed random effects and are uncorrelated with the explanatory variables. When the statistic is statistically significant, the null hypothesis must be rejected in order for the fixed effect model to be used; otherwise, the random effect model is assumed to be used. The rejection of the null hypothesis also suggests that the fixed effect model is a better fit for capturing correlated particular effects.

The following form can be used to describe equation (a).

$$y_{it} = \alpha + X'_{it}\beta + \mu_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

With i representing the firms under consideration and t is representing the time. Hence, the ith subscript, therefore, denote the cross-section dimension whereas the t denotes the time series dimension; $\mathbf{X'_{it}}$ are variables such as oil spillage, also $\boldsymbol{\alpha}$is a constant.

$$\mu_{it} = \pi_i + \varepsilon_{it} \ldots\ldots\ldots\ldots (9)$$

Where π_i denotes the unobservable individual specific effect and ε_{it} denote the remainder disturbance. Linearizing the above equation (1) we have the below model for our each of the objectives adopted for the study.

Objective 1:

$$y_{it} = \alpha + \beta_1 (X)_{1t} + \pi_i + \varepsilon_{it} \ldots\ldots\ldots\ldots(10)$$

$$BOP = \alpha + \beta_2(CIOGF)_{it} + \pi_i + \varepsilon_{it} \dots \dots (11)$$

Were.
BOP = Balance of payment
CIOGF = Cost implication of oil spillage
β_2= Coefficient of the independent variable
π_i = Unobserved specific effect
ε_{it} = Error disturbance

Objective 2:

$$y_{it} = \alpha + \beta_1(X)_{1t} + \pi_i + \varepsilon_{it} \dots \dots \dots \dots (10)$$
$$PI = \alpha + \beta_5(CIOGF)_{it} + \pi_i + \varepsilon_{it} \dots \dots (11)$$

Were.
PI = Poverty Index
CIOGF = Cost implication of oil spillage
β_5= Coefficient of the independent variable
π_i = Unobserved specific effect
ε_{it} = Error disturbance

Data Presentation and Analysis

Data was collected from the financial statements of each company included in the study, as presented on their respective websites, focusing on the relevant years and variables. Descriptive statistics, also known as summary statistics, were provided to describe the nature of the data. To begin, we examined the behaviour of the variables used in this study, using a line plot to investigate their trends. We believe this plot will reveal key characteristics of the data. Table 4.1.1 (See Appendix) shows the company codes, and their meanings as used in the analysis.

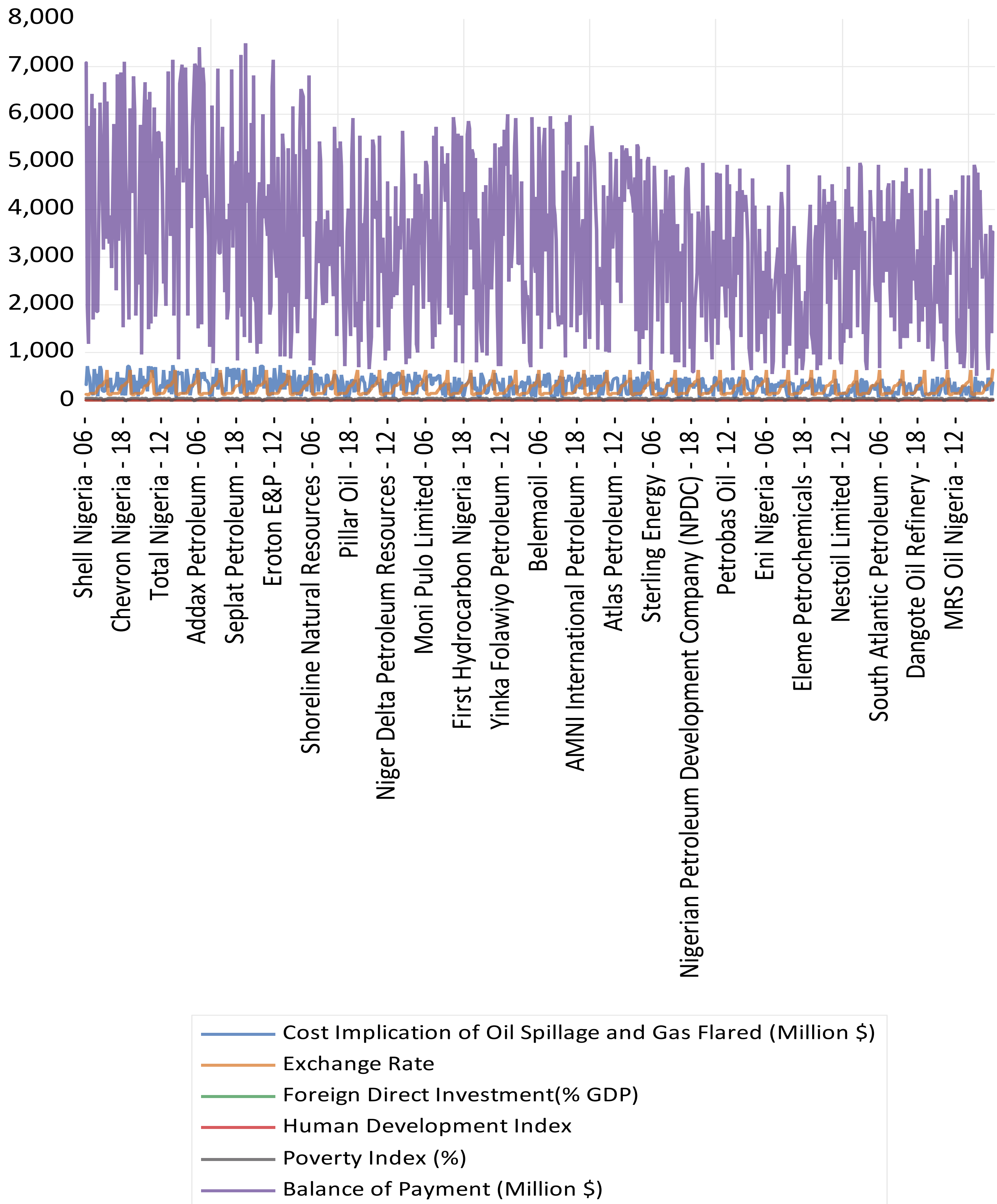

Fig 1: Line plot of the study variable

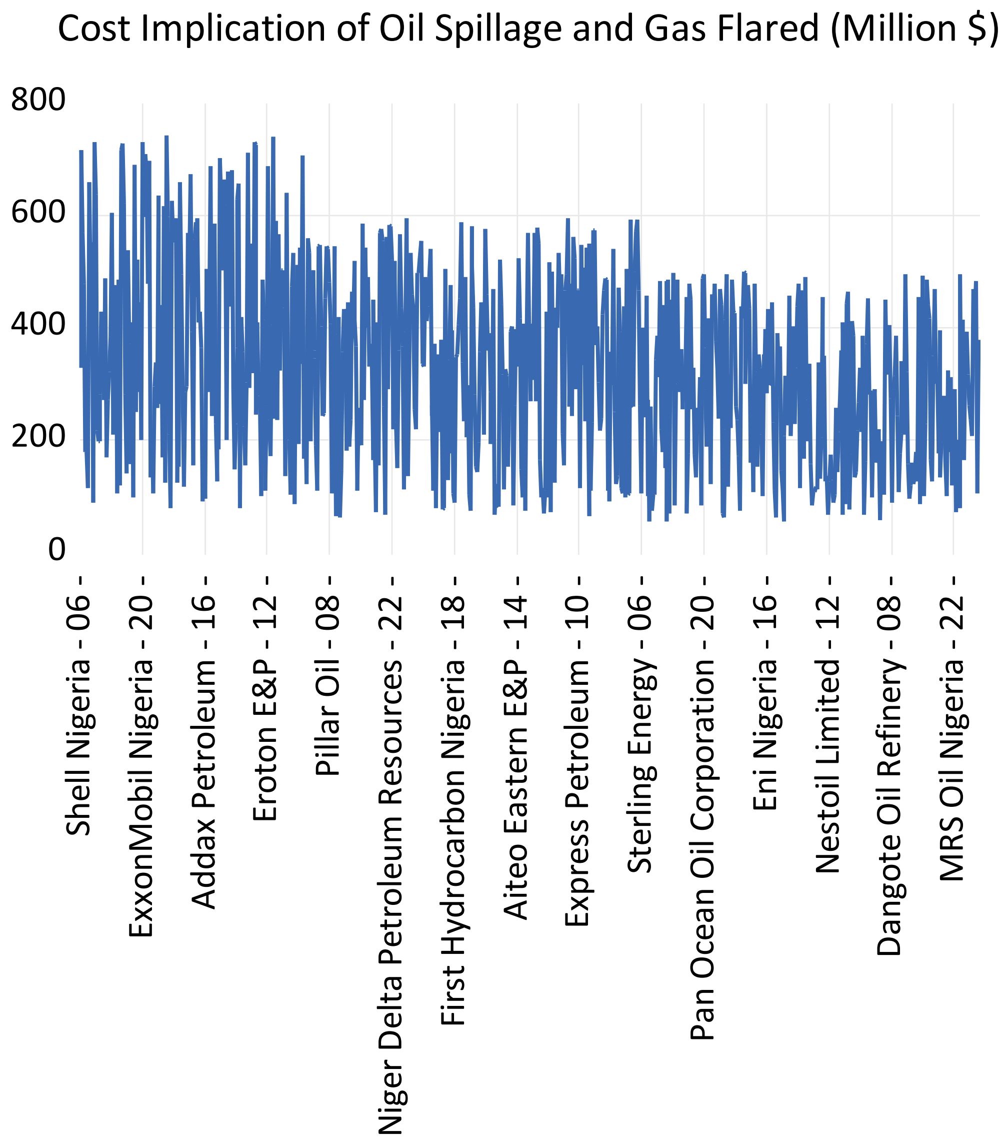

Fig 2: Line plot of cost implication of oil spillage and gas flared

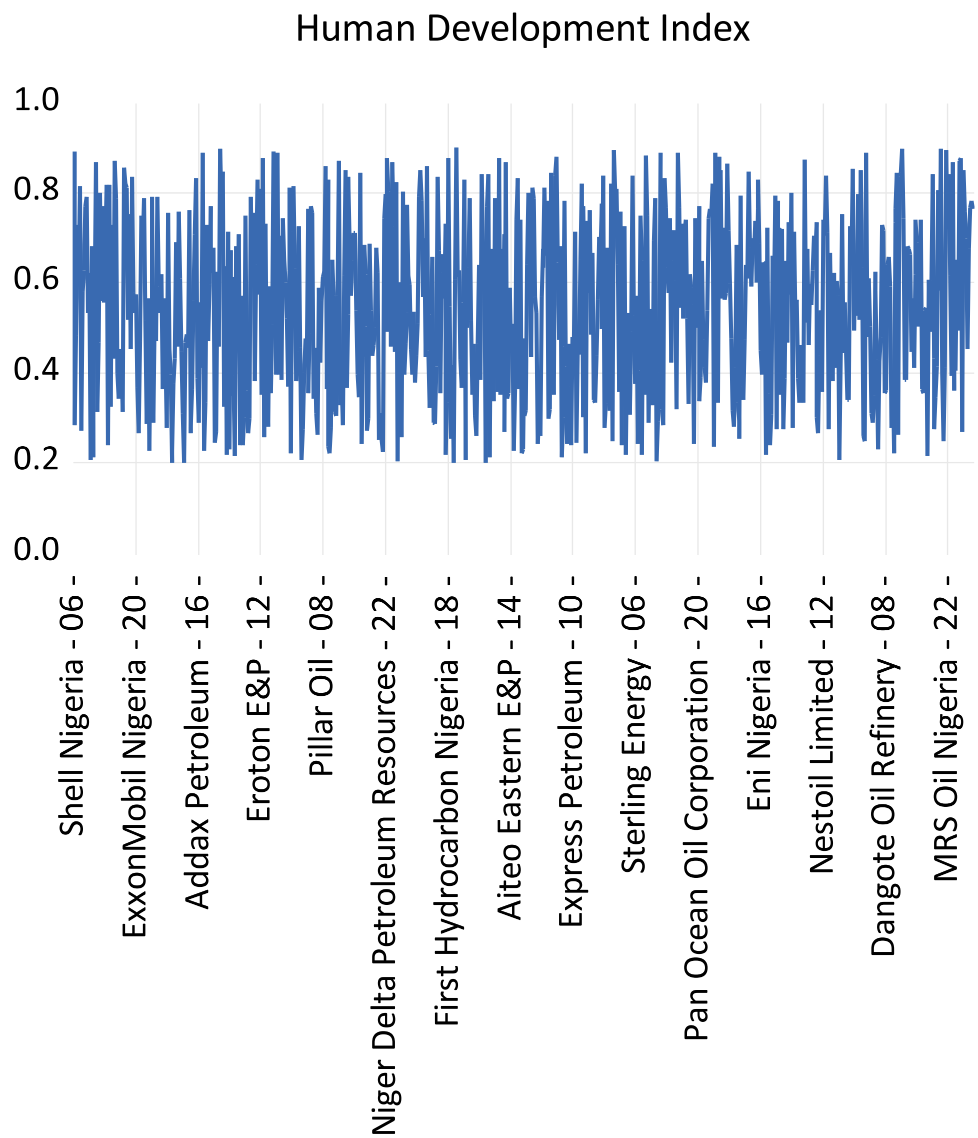

Fig 3: Line plot of human development index

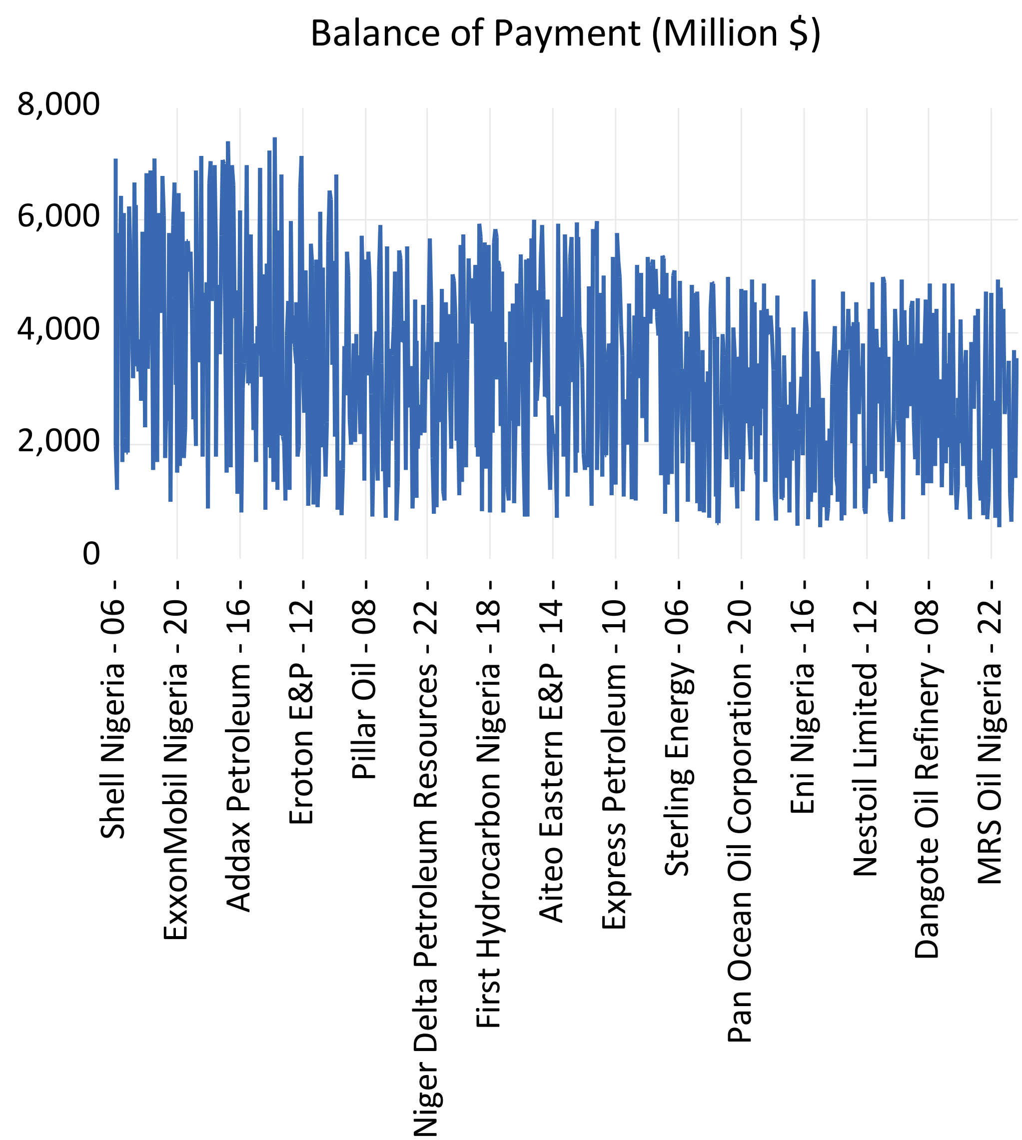
Balance of Payment (Million $)
8,000
6,000
4,000
2,000
0
Shell Nigeria - 06
ExxonMobil Nigeria - 20
Addax Petroleum - 16
Eroton E&P - 12
Pillar Oil - 08
Niger Delta Petroleum Resources - 22
First Hydrocarbon Nigeria - 18
Aiteo Eastern E&P - 14
Express Petroleum - 10
Sterling Energy - 06
Pan Ocean Oil Corporation - 20
Eni Nigeria - 16
Nestoil Limited - 12
Dangote Oil Refinery - 08
MRS Oil Nigeria - 22

Fig 4: Line plot of the balance of payment

Table 1: Summary statistics

	CIOSGF	**BOP**	**PI**			
Mean	325.8789	3302.416	41.4300			
Median	314.7708	3294.248	42.1500			
Maximum	741.1487	7478.901	59.1000			
Minimum	55.10914	522.2299	0.00000			
Std.Dev.	168.3351	1681.854	12.8040			
Skewness	0.290645	0.240093	-1.61812			
Kurtosis	2.197343	2.153180	6.537136			
Jarque-Bera	29.46474	28.43046	689.5373			
Probability	0.00000	0.000001	0.00000			

CIOSGF=Cost Implication of oil spillage; BOP=Balance of payment; PI=Poverty index.

The descriptive of Nigeria's oil and gas results as shown in table 1 reveals significant economic impacts, especially concerning environmental costs. The average cost implication of oil spillage stands at 325.8789, with a high standard deviation of 168.3351, indicating substantial financial burdens and variability in these environmental issues.The balance of payments has a mean of 3302.416, reflecting a positive contribution to Nigeria's international trade balance, although the variability is significant, with a standard deviation of 1681.854. Finally, the poverty index, with a mean of 41.4300 and a standard deviation of 12.8040, underscores the persistent socioeconomic challenges in Nigeria, despite the wealth generated by the oil and gas sector. The high poverty rate indicates that a significant portion of the population continues to live in poverty, and the considerable variability suggests that while the industry may contribute to economic growth, it has not been sufficient to ensure broad-based poverty reduction. This highlights the disparity between the economic contributions of the oil and gas sector and the broader social outcomes in the country.

Shapiro Wilk Test for Normality

Table 2: Shapiro–Wilk W test for normal data

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig	Statistic	Df	Sig
CIOSGF	.058	720	.000	.966	720	.000
FDI	.072	720	.000	.969	720	.000
BOP	.068	720	.000	.958	720	.000
HDI	.217	720	.000	.903	720	.000
ER	.248	720	.000	.814	720	.000
PI	.154	720	.000	.832	720	.000

CIOSGF=Cost Implication of oil spillage; BOP= Balance of payment; PI= Poverty index

Table 2 is the Kolmogorov-Smirnov (K-S) normality test, which is used to determine whether a dataset follows a normal distribution. In this case, the test was applied to six variables: the cost implication of oil spillage, balance of payment index. The test results include coefficients of 0.058, 0.072 and 0.068 for these variables, respectively, with all p-values reported as 0.000. The K-S test coefficients indicate the maximum difference between the observed cumulative distribution and the expected cumulative distribution under the assumption of normality. Lower coefficients suggest a distribution closer to normal, while higher coefficients indicate greater deviation from normality. In this analysis, the coefficients range from 0.058 to 0.248, with the BOP (0.072) and poverty index (0.154) showing relatively higher deviations from normality compared to the other variables. The p-value indicates the probability of observing the data if the null hypothesis (that the data follows a normal distribution) is true. A p-value of 0.000 means the test is highly significant, indicating strong evidence against the null hypothesis of normality. In this case, the p-values for all variables are 0.000, meaning that none of the variables follow a normal distribution.

Table 3: Correlation of Oil spillage with the dependent variables

	CIOSGF	BOP		PI		
CIOSGF	1					
FDI	-0.028 [0.453]					
BOP	0.085 [0.023] *	1				

PI	-0.043 [0.253]	-0.026 [0.490]		1		

CIOSGF=Cost Implication of oil spillage; BOP=Balance of payment; PI=Poverty index.

Table 3 is the correlation analysis between the cost implication of oil spillage and various economic indicators in Nigeria provides insights into the relationships between these factors. The correlation between the cost implication of oil spillage and the balance of payment is 0.085, with a p-value of 0.023. Although this is a weak positive correlation, it is statistically significant, indicating a slight but notable relationship where higher costs of environmental damage might be associated with slight improvements in the balance of payment.

Panel Unit Root Test (Stationary)

This study utilizes Levin and Chu test (LLC) Panel unit root statistic in order to scrutinize the integration properties of all the variables adopted in this study if levels across sectional units contains or do not contain a unit root. Hence for convenient reasons, we are focusing on Levin and Chu test (LLC) test statistic because it can lead to more accurate results about the panel integration properties of the variables.

Table 4: Panel Unit Root Stationary Test

Variables	**Integration order**	**Statistic**	**p-value**
CIOSGF	I (0)	-7.75929	0.0000
FDI	I (1)	-7.61296	0.0000
BOP	I (0)	-8.28339	0.0000

CIOSGF=Cost Implication of oil spillage; FDI= Foreign direct investment; BOP=Balance of payment

This study adopted panel Levin and Chu test (LLC) test as presented in table 4 above to investigate the stationarity of the panel data variables at the level stage and beyond. The panel unit root test results using the Levin, Lin, and Chu (LLC) method for the economic indicators related to Nigeria's oil and gas industry show important insights into their stationarity. The variables tested include the cost implication of oil spillage, balance of payment index. The LLC test coefficients at different levels and integration orders, coupled with the p-values of 0.0000 across the board, indicate strong evidence of stationarity for most of these variables.For the cost implication of oil spillage, the LLC test coefficient at the level, I(0), is -7.75929, with a p-value of 0.0000, indicating that this variable is stationary without requiring differencing. The same conclusion applies to the balance of payment (I (0) = -8.28339) and a p-value of 0.0000, reinforcing that no differencing is needed for these variables. The poverty index also demonstrates stationarity at the level with an LLC coefficient of -16.3657 and a p-value of 0.0000, reinforcing that no differencing is needed for these variables.

Objective One

Table 5: Panel Regression Results Cost implication of oil spillage and gas flaring on balance of payment (Fixed Effect Model, Random Effect Model and Pooled OLS)

Variable	Fixed Effect	Random Effect	Pooled OLS
CIOSGF	0.110303 [0.0171] *	0.6620f26 [0.0006] *	0.923952 [0.0130]
C	3266.471 [0.0000] *	3086.676 [0.000]	3001.320 [0.0000]
R-Square	0.132985	0.004415	0.008552
F-Statistic	2.603669	3.184278	6.193350
Prob (F-Statistic)	0.000001	0.017477	0.01049
Hausman Test			
Test Summary	Chi-Sq Statistic	Chi-Sqd.f.	Prob
Cross-section random	26.450041	1	0.0000

Table 5 is the panel regression result for cost implication of oil spillage on balance of payment. The Hausman test result, with a coefficient of 26.450041 and a p-value of 0.0000, strongly indicates that the fixed effects model is more appropriate than the random effects model for the data. The large test statistic and highly significant p-value lead to the rejection of the null hypothesis that the random effects model is suitable. This suggests that the individual-specific effects in the panel data are correlated with the independent variables, making the fixed effects model more reliable for analyzing the impact of factors like the cost implication of oil spillage and gas flaring on balance of payment in Nigeria's oil and gas industry.

The panel regression analysis using the fixed effects model assesses the impact of the cost implication of oil spillage and gas flaring on Nigeria's balance of payments. The results show a positive coefficient of 0.110303, indicating that as the cost implication of oil spillage and gas flaring increases, the balance of payments also tends to increase by approximately 0.1103 units, holding other factors constant. This relationship is statistically significant, as evidenced by the p-value of 0.0171, which is below the 0.05 threshold, suggesting that the effect is not due to random chance. The model's R-squared value is 0.132985, meaning that approximately 13.30% of the variation in the balance of payments is explained by the cost implications of oil spillage and gas flaring. While this indicates that the model captures some of the relationship, a significant portion of the variation is explained by other factors not included in the model. The F-statistic of 2.603669, with a highly significant p-value (Prob(F-statistic) = 0.000001), suggests that the model as a whole is statistically significant, meaning that the explanatory variables jointly have a significant impact on the balance of payments. In summary, the fixed effects model suggests a statistically significant positive relationship between the cost implications of oil spillage and gas flaring and the balance of payments in Nigeria. However, the relatively low R-squared value indicates that other variables may also play a critical role in influencing the balance of payments.

Hypothesis Two

H_{01}: The cost implications of oil spillage have no significant positive impact on the balance of payments in Nigeria between 2006 and 2023.

Decision

Table 5 above suggest that at 5% level of significance cost implication of oil and gas flaring (p-value = 0.0171) significantly affect the balance of payment of oil and gas industries in Nigeria.

Objective Two

Table 6: Panel Regression Results Cost implication of oil spillage on poverty index (Fixed Effect Model, Random Effect Model and Pooled OLS)

Variable	**Fixed Effect**	**Random Effect**	**Pooled OLS**
CIOSGF	-0.004232 [0.0018] *	-0.003735 [0.0201] *	-0.003735 [0.0188] *
C	42.80927 [0.0000] *	42.64720 [0.0000] *	42.64720 [0.0000] *
R-Square	0.273200	0.024119	0.241160
F-Statistic	5.046511	3.735557	7.735557
Prob (F-Statistic)	0.010018	0.019123	0.018812
Hausman Test			
Test Summary	Chi-Sq Statistic	Chi-Sqd.f.	Prob
Cross-section	0.218610	1	0.6401

random			

Table 6 is the panel regression result for cost implication of oil spillage and gas flaring on the poverty index. The Hausman test result with a test statistic of 0.218610 and a p-value of 0.018812 suggests that the fixed effects model is more appropriate for this analysis than the random effects model. This value is relatively small but suggests some difference between the coefficients estimated by the fixed and random effects models. A higher value would indicate a larger difference between the two models. The p-value is less than the conventional significance threshold of 0.05, which leads to the rejection of the null hypothesis of the Hausman test. The null hypothesis assumes that the random effects model is appropriate, meaning the individual-specific effects are uncorrelated with the independent variables. Since the p-value is significant, this indicates that there is a correlation between the individual-specific effects and the regressors, making the fixed effects model a better choice.

The panel regression result for the random effects model examines the impact of the cost implications of oil spillage and gas flaring on the poverty index. The coefficient of -0.004232 indicates a negative relationship, meaning that as the cost implication of oil spillage and gas flaring increases by one unit, the poverty index decreases by approximately 0.004232 units. This suggests that higher costs associated with environmental damage may correlate with a reduction in the poverty index. The p-value of 0.0018 shows that this relationship is statistically significant at the 5% level, indicating a strong association between the two variables. The R-squared value of 0.273200 suggests that 27.32% of the variation in the poverty index can be explained by the cost implications of oil spillage and gas flaring in the model. The F-statistic of 5.046511 and its associated p-value of 0.010018 further support the model's overall significance, indicating that the explanatory variable (cost of oil spillage and gas flaring) significantly affects the poverty index when considered within the model. In conclusion, the results show a statistically significant but modest negative effect of the cost implications of oil spillage and gas flaring on the poverty index. The moderate R-squared value suggests that while this factor plays a role in influencing poverty levels, other unexamined variables also have a significant impact on poverty.

Hypothesis Five

H_{01}: The cost implications of oil spillage have no significant impact on the poverty index in Nigeria between 2006 and 2023.

Decision

Table 6 above suggest that at 5% level of significance cost implications of oil spillage and gas flaring (p-value = 0.0018) have a significant impact on the poverty index in Nigeria between 2006 and 2023. Hence, we reject the null hypothesis.

Diagnostic Test for the models

Table 7: Residual Cross-Section Dependence Test and Panel Cross Sectional Heteroskedasticity LR Test.

	Residual Cross-Section Dependence Test	
	Breusch-Pagan LM (P-value)	Pesaran scaled LM (P-value)
Model 1	808.3090 (0.2342)	0.716740 (0.4735)
Model 2	139.45833 (0.6346)	4.288601 (0.3090)
	Panel Cross Sectional Heteroskedasticity LR Test	
	Likelihood Ratio Test (P-value)	Restricted Logl
Model 1	48.26284 (0.1735)	-6365.953
Model 2	-2856.092 (1.0000)	-2856.092

Table7 is the Residual Cross-Section Dependence Test and Panel Cross Sectional Heteroskedasticity LR Test. For the residual cross-section dependence test evaluates whether there is correlation across different cross-sectional units in panel data. The Breusch-Pagan LM and Pesaran scaled LM tests are two common methods for diagnosing this dependence.

Model 1

1. Breusch-Pagan LM = 808.3090, p-value = 0.2342
2. Pesaran scaled LM = 0.716740, p-value = 0.4735

In Model 1 the p-values for both tests are above the 0.05 threshold, suggesting that there is no significant cross-sectional dependence. The residuals are independent across cross-sectional units, and no further corrections are required for dependence in this model.

Model 2

1. Breusch-Pagan LM = 139.45833, p-value = 0.6346
2. Pesaran scaled LM = 4.288601, p-value = 0.3090

For Model 2, both tests yield non-significant p-values, similar to the other models. This further supports the absence of cross-sectional dependence. The independence of residuals ensures that the model can be trusted for its results without the risk of biased estimates due to cross-sectional correlation.
Therefore, across all five models, both the Breusch-Pagan LM and Pesaran scaled LM tests show non-significant p-values, consistently indicating the absence of cross-sectional dependence. This result suggests that the panel data models are well-specified and that cross-sectional correlation does not pose a threat to the validity of the estimated coefficients.

The results of the Panel Cross-Sectional Heteroskedasticity LR Test for multiple models show no significant evidence of heteroskedasticity across the cross-sectional units.
In Model 1, the LR test statistic is 48.26284, and the p-value is 0.1735, which still does not provide enough evidence to reject the null hypothesis of homoskedasticity. and Model 2 shows an LR test statistic of 139.45833 with a p-value of 0.6346. All the models consistently reflect no significant heteroskedasticity, implying that the variance of the residuals is stable across the cross-sectional units, thereby confirming the robustness of the regression models used in this analysis.

Table 8: Multicollinearity Test

S/n	Variable	VIF
1	cost implications of oil spillage	1.003
2	Balance of payment	1.009
3	Poverty index	1.106

Table 8 is the Variance Inflation Factor (VIF) analysis for the variables in the model reveals that multicollinearity is not a significant concern. With VIF values close to 1 for most variables, such as the cost implications of oil spillage (1.003), balance of payment (1.009), and Poverty index (1.106), which have slightly higher VIF values, the level of multicollinearity is still low, indicating that these variables do not share a strong relationship with the other predictors. The low VIF values across all variables suggest that each variable contributes unique information to the model and can be interpreted independently without the risk of multicollinearity distorting the regression coefficients. This ensures the reliability of the regression analysis and the accuracy of the individual effect estimates for each predictor variable in the model. Therefore, the results of the model can be trusted to provide clear insights into the relationships between the predictors and the dependent variable.

Discussion of findings

The results of the panel regression analysis using the fixed effects model provide critical insights into the impact of the cost implications of oil spillage and gas flaring on the balance of payments (BOP) in Nigeria's oil and gas industry. The Hausman test results, with a coefficient of 26.450041 and a p-value of 0.0000, strongly indicate that the fixed effects model is appropriate for the data. This suggests that the individual-specific effects in the panel data are correlated with the independent variables, a factor that makes the fixed effects model more suitable than the random effects model. The implication of this is that oil spillage and gas flaring are not randomly occurring across the different periods and states but are tied to specific economic and environmental contexts that need to be considered in the analysis. This is in line with the findings of Jayasooriya (2020), who similarly employed a panel data approach to analyse the relationship between exchange rates and the BOP in South Asia, indicating the importance of using fixed effects to capture country-specific economic dynamics.

The positive coefficient of 0.110303 implies that increases in the cost implications of oil spillage and gas flaring tend to positively influence Nigeria's balance of payments. This result is statistically significant (p-value = 0.0171), indicating that the effect is unlikely to be due to random chance. This aligns with the findings of Mangwendeza (2020), who also found a significant long-run relationship between the BOP and economic growth in Namibia, suggesting that resource-based economies like Nigeria are similarly influenced by environmental and economic factors, including oil-related issues. However, the low R-squared value of 0.132985 indicates that other factors not captured in this model account for a significant portion of the variation in the BOP. This suggests that while the cost implications of oil spillage and gas flaring are significant, they are not the only determinants of the BOP, a point echoed in studies like that of Sujianto (2020), who identified multiple macroeconomic factors influencing the BOP, including exchange rates, inflation, and national income.

The statistically significant positive relationship between the cost implications of oil spillage and gas flaring and the BOP may seem counterintuitive, given the generally negative connotations associated with environmental degradation. However, this finding could be explained by the notion that the economic costs of mitigating or addressing oil spillage and gas flaring, such as through clean-up efforts or fines, might be absorbed by the industry and passed on to international buyers through higher oil prices. This echoes the findings of McGuire, Holtmaat, and Prakash (2022), who reported that environmental accidents, while damaging to corporate reputation, do not necessarily depress stock market performance in the long run. Similarly, the Nigerian oil and gas industry may be able to offset the negative environmental externalities of oil spillage and gas flaring through adjustments in pricing, maintaining a positive effect on the BOP.

When compared to the broader literature on BOP dynamics, these findings agree with some studies but diverge from others. For instance, the results are consistent with the findings of Lélis et al. (2018), who also found that external factors such as oil prices and environmental constraints can impact the BOP in Brazil. On the other hand, Razak and Masih (2018) reported an asymmetric relationship between exchange rates and the trade balance in Malaysia, suggesting that external shocks, including environmental degradation, might have different short- and long-term impacts on the BOP depending on how domestic markets and policy frameworks respond. This divergence highlights the complexity of the relationship between environmental costs and macroeconomic indicators like the BOP, emphasizing the need for country-specific analyses.

The fixed effects model shows a statistically significant positive relationship between the cost implications of oil spillage and gas flaring and Nigeria's balance of payments. This finding agrees with the broader literature that acknowledges the importance of environmental factors in shaping macroeconomic outcomes but also suggests that these effects may vary depending on country-specific economic structures and external factors. While the results are robust, the relatively low explanatory power of the model points to the need for further research to identify other critical variables that influence the BOP in oil-dependent economies like Nigeria.

The panel regression results from Table 4.6.5 demonstrate that the cost implications of oil spillage and gas flaring have a significant negative relationship with the poverty index, as indicated by the Hausman test and the fixed effects model. The test statistic of 0.218610 and a p-value of 0.018812 suggest that the fixed effects model is more appropriate for this analysis, rejecting the null hypothesis that assumes the random effects model is more suitable. The fixed effects model reveals a coefficient of -0.004232, meaning that as the cost implications of oil spillage and gas flaring increase, the poverty index decreases. This relationship is statistically significant, with a p-value of 0.0018, suggesting that the costs associated with environmental degradation can influence poverty levels in the observed regions.

The finding of a negative relationship between oil spillage, gas flaring, and poverty seems counterintuitive at first, given the widespread literature that suggests environmental degradation exacerbates poverty. For instance, Dar and Singh (2021) posit that environmental degradation contributes to poverty by depleting the natural resources upon which the poor depend. Similarly,
Agadon et al. (2023) reported that the government provided food packs and financial assistance to communities affected by oil spills in the Philippines, though participants deemed these efforts insufficient. The results from the current study may reflect such temporary mitigation measures that reduce the observable poverty index, despite the long-term environmental degradation.

Furthermore, the moderate R-squared value of 0.273200 indicates that while the cost implications of oil spillage significantly affect poverty, other unexamined variables are likely to play a substantial role. This aligns with Estevo et al. (2021), who found that the immediate social and economic impacts of oil spills significantly affected local fishing communities, reducing their income. The broader social implications, such as reduced employment opportunities and long-term environmental degradation, were not captured entirely by their study's quantitative measures.
The study's findings also contrast with Aitken and Kuralbayeva (2022), who examined the socioeconomic effects of oil spillage in Kazakhstan and found that it exacerbated poverty by degrading the environment, leading to health issues and reduced access to agricultural land. Their results emphasize the environmental and health-related consequences of gas flaring, suggesting that even when economic variables like poverty indices may temporarily improve, the long-term impacts are detrimental to both human health and socio-economic stability.

The significant F-statistic (5.046511) and its associated p-value (0.010018) further affirm the overall significance of the model. However, Henry et al. (2023), investigating oil exploration in Guyana, found that oil spills caused significant damage to community assets and reduced economic productivity, indicating that the long-term consequences of environmental degradation are likely to outweigh any immediate or temporary reductions in poverty.

In contrast, Baghdady and Abdelsalam (2024) highlighted the economic hindrances caused by frequent oil spills in Egypt's Mediterranean region. Their study utilized remote sensing technologies to detect an increasing number of oil spills, leading to disruptions in shipping, fisheries, and tourism. These findings align with the broader consensus in the literature, which suggests that oil spills have far-reaching consequences beyond immediate financial costs and may lead to long-term socio-economic deterioration.

The negative relationship between the cost implications of oil spillage on poverty suggests that, in the short term, increased costs may be associated with government or corporate interventions aimed at alleviating the immediate economic hardships of affected populations. This could explain why the poverty index decreases as these costs rise. However, as Moussaoui andIdelhakkar (2023) and others have demonstrated, the long-term economic and environmental consequences of oil-related disasters are far more severe and are likely to lead to increased poverty over time.

The findings of this study indicate the importance of considering both immediate and long-term consequences when evaluating the socio-economic impacts of environmental degradation. While short-term mitigation efforts may temporarily reduce poverty, as indicated by the negative relationship found in this study, the long-term effects of oil spillage and gas flaring on health, access to natural resources, and economic productivity are likely to exacerbate poverty in the future.
While this study finds a statistically significant negative relationship between the cost implications of oil spillage and the poverty index, the broader literature suggests that this relationship may be driven by temporary mitigation efforts rather than a genuine reduction in poverty. Long-term studies, such as those by Dar and Singh (2021), Klimenko and Shkaruba (2021), and Aitken and Kuralbayeva (2022), demonstrate the broader and more severe socio-economic impacts of environmental degradation, highlighting the importance of taking a long-term perspective when assessing the costs of oil spillage and gas flaring on poverty.

Summary of Findings

The impact of oil spillage on various economic and social indicators in Nigeria from 2006 to 2023. The findings are summarised as follows:

i. The cost implications of oil spillage have a significant impact on the balance of payments in Nigeria. With a t-statistic of 0.110303 and a p-value of 0.0171, the results indicate a significant effect at the 5% significance level. The R-squared value of 0.132985 shows a relatively low level of explanation, but the effect is significant.

ii. The cost implications of oil spillage significantly affect the poverty index in Nigeria. With a t-statistic of -0.004232 and a p-value of 0.0018, the results are statistically significant at the 5% level. The R-squared value of 0.273200 indicates a moderate level of explanation of the variability in the poverty index, suggesting that oil spillage and gas flaring have a notable effect on poverty.

Conclusion

This study has investigated the cost implications of oil spillage by oil companies on various facets of the Nigerian economy between 2006 and 2023. Between 2006 and 2023, However, they have exerted a notable positive influence on Nigeria's balance of payments, as the revenue from oil exports—despite the inefficiencies and costs—contributed to stabilising trade imbalances.

Finally, the impact on the poverty index has been significant, as oil spillage and gas flaring have exacerbated economic disparities. While revenues from oil may have bolstered certain sectors, the environmental and social costs, particularly in oil-producing communities, have contributed to rising poverty levels. This suggests that while the economic gains have been evident in some macroeconomic indicators, the broader societal and environmental costs have hindered equitable and sustainable development.The study concluded that the cost implications of oil spillage by oil companies in Nigeria had a significant effect on the Nigerian economy between 2006 and 2023.

Recommendations

Based on the economic and environmental outcomes of oil spillage and gas flaring in Nigeria between 2006 and 2023, several strategic recommendations are essential for mitigating their negative impacts while maximizing economic gains.

i. Although oil revenue has positively contributed to the balance of payments, reliance on oil exposes Nigeria to external shocks. To reduce economic vulnerability, the government should accelerate diversification efforts into other sectors like agriculture, technology, and renewable energy, which can provide more stable sources of income and reduce the impact of oil-related environmental costs.

ii. The significant impact of oil spillage and gas flaring on poverty highlights the need for equitable resource distribution, particularly in oil-producing regions. The government should prioritize development programs that directly benefit local communities affected by environmental damage, including compensation schemes, job creation, and environmental rehabilitation.

Contribution to Knowledge

The study of oil spillage and gas flaring by oil companies in Nigeria has traditionally focused on their environmental and health consequences. However, understanding their broader economic impact is crucial for comprehensive policy development. This contribution to knowledge provides an in-depth analysis of how these environmental issues have affected key economic indicators in Nigeria between 2006 and 2023. Contrary to common assumptions, the findings reveal that the cost implications of oil spillage and gas flaring have had no significant positive impact on foreign direct investment (FDI), balance of payments, human development index (HDI), exchange rate, or poverty index.

i. **Balance of Payments:** The study offers a nuanced perspective on the impact of oil spillage and gas flaring on Nigeria's balance of payments. Despite oil being a major export commodity, the findings reveal that these environmental issues have not led to significant positive effects on the balance of payments. This suggests that the detrimental economic effects of oil spillage and gas flaring, including potential losses from environmental damage and reduced production capacity, outweigh any possible benefits.

ii. **Poverty Index:** The study contributes to knowledge by demonstrating that oil spillage and gas flaring have not had a significant impact on the poverty index. This result indicates that the adverse economic effects of environmental degradation may not directly translate into significant changes in poverty levels at the national level. It highlights the complexity of poverty dynamics and the need for targeted interventions to address the specific challenges faced by communities affected by oil extraction activities.

Suggestions for Further Studies

i. **Environmental Degradation and International Trade Relations:** Future research could examine how environmental degradation from oil spillage and gas flaring influences Nigeria's international trade relations and agreements. By investigating whether these environmental issues affect the country's trade competitiveness, researchers could better understand the broader implications for Nigeria's balance of payments.

ii. **Examining Socio-Environmental Conflicts and Economic Growth:** Given the history of socio-environmental conflicts in Nigeria's oil-producing regions, future studies could investigate the economic costs of these conflicts as they relate to oil spillage. By quantifying the economic impact of such conflicts, researchers can offer insights into the broader implications for economic growth, human development, and poverty reduction.

Limitations of the Study:

Many obstacles were encountered along the course of this research:

i. **Cost attribution**: It is not always easy to separate the monetary losses caused by oil spills from those caused by other causes. It is difficult to disentangle the effect of these environmental problems from economic indicators because of the many other factors that affect them.

ii. **Health and Environmental Impacts**: It is difficult to put a price on the human and planetary health impacts of oil spill. It is difficult to quantify the health effects on local populations, the ecological harm that will persist over time, and the loss of biodiversity.

iii. **Projecting into the future:** Because of factors such as the possibility of changes in regulatory laws, technical developments, and changes in the global oil markets, it is difficult to anticipate the economic implications of present trends in the future.

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