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Crude Oil By-Products Price Movements and Standard of Living: Evidence from Nigeria

James Ese Ighoroje[1]*, Chiyem Okorie[2], Kelvin Agbarha Egberi[3]

[1]Department of Banking and Finance, Delta State University of Science and Technology, Ozoro, Nigeria, [2]Department of Marketing, Delta State University of Science and Technology, Ozoro, Nigeria, [3]Department of Business Administration, Delta State University of Science and Technology Ozoro, Nigeria. *Corresponding Author's Email: eseroji@gmail.com

Abstract

Crude oil deposits have occasioned over-dependence for most Nigerians, forming a single, high-valued commodity as a primary source of earnings exposure. Nevertheless, crude oil product prices are highly volatile. This study analyzed the impact of changes in the prices of crude oil by-products price movements on standard of living in Nigeria from 1989 to 2021. The changes in crude oil product prices are disaggregated into costs of oil price per barrel movements (OPBM), Diesel Pump Price Movements (DPPM), Petroleum Pump Price Movements (PPPM), and Kerosene Pump Price Movements (KPFF), while the regressed per capita income as a proxy for living standards in Nigeria. The data were analyzed using econometric methods, specifically the Unit Roots tests, Fully Modified OLS (FMOLS) Granger causality test and Generalized Method of Moments (GMM). The result established that OPBM- Oil Price per Barrel Movements and Petroleum Pump Price Movements reduce per capita income significantly while KPPM- Kerosene Pump Price Movements minimally reduce per capita income. However, DPPM- Diesel Pump Price Movements improve per capita income minimally. The study concludes that the overall reliance on crude oil is behind the improvised state of Nigerians. To reduce Nigerians' (especially OPBM and PPPF) dependence on crude oil by-products, mostly OPBM local pump prices should be lowered. Again, the government should re-direct its revenue towards improving the standard of living. The study is novel as it provides a robust economic policy model linking crude oil by-products and Nigeria's living standard.

Keywords: Diesel Prices, Kerosene Prices, Oil Prices, Petroleum Prices.

Introduction

Over the years, about 400 million ancient algae and plankton died and sank to the ocean floor, leaving behind the remnants now known as crude oil. They were buried under a thick layer of mud and debris. Petroleum, jet fuel, diesel, gasoline, and oil for heating and power production are just a few of the many transportation fuel products that may be made from crude oil. In addition to asphalt, paraffin, and lubricating oil, crude oil may also be refined into various goods and Chemicals, including fertilizer, pesticide, soap, perfume, and vitamin capsules, (which are all made from crude oil (1). The by-products derived from refined crude oil are utilized as energy sources in homes, factories, and various industrial facilities. These commodities facilitate the smooth functioning of businesses, individuals and households contributing to increased productivity, higher revenue, reduced production costs, and an overall improvement in the quality of life of these energy-dependent segments of the economy (2). Notably, the import of crude oil resulted in fluctuations in its price becoming a critical factor in industrial, manufacturing, and national production, and consequently, impacting the quality of life for people across the country (3). Worthy to note is that, income generated from the sale of crude oil and its by-products have played a pivotal role in the Nigerian government's finances since its discovery in 1958. Over the years, approximately 35% of the Gross Domestic Product (GDP) and 90% of export revenues are derived from the crude oil and gas industry. Nigeria possesses substantial proven natural gas reserves, totaling around 5.28 trillion cubic feet, making her the African nation with the largest reservoir of natural gas and placing it among the top ten globally (2). The country also boasts estimated crude oil reserves of 37 billion barrels. Despite these abundant resources, Nigeria experienced its slowest growth

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in 25 years in 2016, largely attributed to fluctuations in Crude oil Price COP and frequent attacks on oil infrastructure, contributing to growth indicators negatively (2). However, the disruption in the global economy due to financial depression called for policymakers to re-validate the counter-productive effect, crude oil price fluctuations have on the global economy (4).

Oil by-product price changes, also known as price swings or volatility, occur when prices fluctuate widely over an extended period, followed by more stable conditions, as defined by Gujarati and Porter (5). Both global demand and supply factors contribute to the volatility in oil prices, with potential causes including increased oil demand in Asia and political instability in oil-producing Middle Eastern nations (6). Oil-importing nations, over time, have been significantly affected by this disruption. Nigeria, possessing abundant mineral resources such as oil, coal, and zinc, Nigeria had to import petroleum products overseas since her refineries collapsed in the late 1980s, rendering the economy vulnerable to oil price fluctuations (4). In contrast, the Nigerian oil industry generates revenue through the sale of crude oil, taxes on oil exploration firms, and oil rentals. The sale of crude oil, proportional to both its price and production volume, stands out as the most significant factor. Oil income, defined as the money an economy receives from selling crude oil, is vital for funding government initiatives in a country like Nigeria with a substantial oil industry. The prudent utilization of these funds is anticipated to advance economic development and public welfare. Decreased revenues or losses could pose challenges for oil-exporting nations if oil prices continue to decrease. Nigeria, with its abundant natural resources, fertile land, and enterprising spirit, possesses numerous advantages (7).

The fluctuations in crude oil prices (COP) have profound implications for the quality of life. Firstly, crude oil by-products (especially premium motor spirits) derived from crude oil are neither human health (quality of life) nor environmentally friendly (7). The extensively documented benefits of the affordable and available include lower production costs, heightened productivity, and increased revenue (8, 9). Moreover, the use of the products in hospitals and schools not only facilitates exceptional healthcare and education but also contributes to stress reduction and longer life expectancy. Consequently, changes in the prices of petroleum impact the overall quality of life, particularly in countries with abundant crude oil reserves (10). Notably, a significant portion of the Nigerian population remains impoverished and vulnerable, significantly diminishing their purchasing power and quality of life due to these unprecedented swings and fluctuations. The expenditure of living is adversely affected when gasoline and other petroleum products are excessively priced at the pump, and conversely, it improves when prices are lower. In Nigeria, hydro-power and fossil fuels (coal, gas, and crude oil) dominate energy production. The Nigerian government aims to leverage hydro-power, the primary energy source, to supply power to factories and homes through the national grid. However, the national grid's power supply has proven to be inconsistent, leaving many Nigerians without electricity. The term "standard of living" has a wide range of meanings, depending on who you ask or where you go (10-13). In a nutshell, it refers to the combination of a person's standard of living in terms of the amount and quality of goods and services consumed regularly (14). It's also about how well-off a group of people are in terms of lifestyle amenities like money, housing, and transportation in a certain location.

The estimation of the standard of living often revolves around per capita income (PCI), which can indirectly impact sustainable development through its influence on economic growth (7). Historically, the average income per person has been a conventional gauge of a society's prosperity, often without considering the inter-temporal dimension along which PCI might affect sustainable development (7). PCI level can shape economic growth, subsequently influencing sustainable development. From a broader perspective, standard of living covers the degree of affluence, comfort, material goods, and necessities available to individuals within an economy or geographic region. It addresses issues related to income level, poverty rate, access to quality health care and education, level of employment, class disparity, access to financial services, and cost of products. The standard of living is proxied by per capita income (PCI) because it reflects the average income per individual and serves as a reliable indicator of an individual's ability to afford goods and services essential for well-being. However, it

also considers other qualitative factors, such as access to healthcare, education, and infrastructure, which are indirectly influenced by income and the government's revenue from crude oil by-products. Premium motor spirit contributes to elevating living standards in various ways, such as its eco-friendly nature, cost reduction in production, increased productivity and revenue, and more. Additionally, it promotes relaxation and longevity, with healthcare and educational facilities relying on it to maintain high standards. Lower prices for premium motor spirit can alleviate inflationary pressure in countries with abundant crude oil reserves, establishing a direct correlation between oil price fluctuations and living conditions (14). The expenditure of living is adversely affected when petroleum goods are expensive and vice versa. Historically, premium motor spirit in Nigeria spans several decades. Notably, during General Gowon's military dictatorship, the price of gasoline increased from 6 to 8.45 kobo. Subsequent administrations continued to adjust prices, with General Obasanjo's military government raising it to 15.37 kobo in 1978, General Ibrahim Babangida raising it by 39.5 kobo in 1986, and further adjustments in subsequent years (15). The price reached 60 kobos per litre for individual vehicles on January 1, 1989, while remaining at 42 kobos for commercial vehicles (16).

Furthermore, Nigeria boasts a diverse range of energy options, with hydro-power and fossil fuels (coal, gas, and crude oil) being the most prevalent. The anticipation is that hydro-power will serve as the primary energy source through the national grid in Nigeria, catering to commercial, industrial, and residential consumers (17). However, due to the documented erratic power supply from the national grid, many Nigerians have turned to premium motor spirit as an alternative power source (18). Ocheni (19) argues that the instability of the national power system in Nigeria makes premium motor spirit a more reliable option for manufacturing. Additionally, Ocheni (19) suggests that frequent blackouts in the national power grid have led to increased dependence on PMS for industrial production and household standards of living. This underscores the pivotal role of petroleum price fluctuations in shaping industrial and manufacturing output as well as overall quality of life in the country (2).

Certainly, economic concerns and apprehension are prevalent among most African families, primarily stemming from the fluctuations in petroleum prices. The reason for this lies in the potential adverse impact that an increase in gasoline and other premium motor spirit prices can have on people's living standards. A continuous rise in the domestic pump price of premium motor spirits may elevate production costs and, if sustained, lead to a reduction in output. Consequently, these factors could trigger layoffs, decreased income, and weakened consumer demand. If production, income, and demand decrease concurrently, the imbalance in supply and demand may result in significant inflation. The culmination of these factors may contribute to a downward spiral into poverty, ultimately diminishing people's living standards (20).

In light of the recent surge in prices for both gasoline, escalating from ₦200 to ₦650, and the concurrent increase in gas prices up to ₦1000 per kg due to the removal of fuel subsidy, the standard of living in Nigeria has witnessed a drastic decline (16). This study is motivated by the desire to evaluate how oil price movements impact on standard of living. The ultimate goal is to model an economic policy aimed at enhancing the standard of living within the African context. Meanwhile, as of the end of 2010, Nigeria possesses a crude oil reserve of 37.2 billion barrels, ranking it as the second-largest in Africa, surpassed only by Libya, and the tenth-largest globally. Nigeria stands as the largest exporter in Africa and the eighth-largest worldwide, with an average daily production of 2.4 million barrels (16). Despite generating billions in revenue in Nigeria, it has not deciphered into an improved economy unlike other oil-exporting nations such as Venezuela, Saudi Arabia, and Algeria, and for almost the last twelve years, she has had to import almost half of the oil items she uses every day. Nigeria is both a significant importer of refined premium motor spirit and the world's eighth-largest producer of crude oil remains a perplexity to the remaining part of the globe. Nigeria's daily oil production of 2.4 million barrels is impeded by its four refineries, operating at only around 40% of installed capacity, and twenty-two depots. In contrast, Venezuela boasts 14 refineries processing 1.28 million barrels of crude oil per day (21).

The decision to focus on oil by-products such as diesel, petrol, and kerosene is primarily due to their direct and immediate influence on consumer expenditure and household budgets in Nigeria. While crude oil prices have a global impact, oil by-products directly affect domestic markets, particularly in economies like Nigeria, where the infrastructure for refining and distributing these products is underdeveloped. These products directly impact the daily expenses of consumers, transportation costs, and inflation in Nigeria. Unlike crude oil prices, which primarily affect global trade and revenue for oil-exporting nations, oil by-products are a significant part of household consumption. Furthermore, the supply chain for these by-products often suffers from inefficiencies, such as transportation bottlenecks and pricing fluctuations due to refining capacity limitations. These factors make oil by-products more directly relevant to the standard of living in Nigeria than crude oil prices themselves.

Additionally, the supply chain for crude oil is largely global, with prices affected by international demand and OPEC policies. However, oil by-products are refined domestically or imported, with their pricing heavily influenced by local factors such as refining capacity, distribution inefficiencies, and government subsidies. These dynamics create unique price fluctuations for oil by-products, which, in turn, significantly influence transportation costs, Of course, the pricing of oil derivatives in Nigeria is not only a domestic issue but is also influenced by global oil price volatility, which is shaped by OPEC regulations, geopolitical conflicts, and fluctuations in global demand. OPEC's decisions on oil production quotas can cause price shocks that trickle down to domestic markets, affecting the cost of refined oil by-products such as petrol and kerosene. Geopolitical conflicts, particularly in major oil-producing regions like the Middle East, also create supply uncertainties, leading to price spikes in the global market, which in turn increase the cost of oil derivatives in Nigeria. For example, disruptions in crude oil supply during periods of global conflict or economic sanctions can lead to increased import costs for refined products, directly influencing domestic prices and the standard of living.

Given the current realities that majority of Nigerians are yet to access electricity coupled with the fact that both the rich and poor depends on crude oil by-products (petrol specifically) rationale why the topic is directed towards crude oil by-products. This further confirmed that change in the crude oil by-products will have more adverse direct effect on the standard of living of Nigerians than changes in crude oil itself.

Theoretically, the Supply and Demand Interaction Theory formed the anchorage of this study. The theory posits that fluctuations in COP by-products, such as premium motor spirit (PMS), are driven by the interplay of supply and demand forces in the global and domestic markets. According to this theory, changes in the global demand for petroleum products, geopolitical factors affecting supply chains, and domestic economic conditions collectively influence the pricing dynamics of crude oil by-products. The study hypothesizes that an increase in COP by-products, particularly premium motor spirit, will positively correlate with the standard of living in Nigeria. This is based on the assumption that higher prices indicate a robust global and domestic economy, potentially leading to increased income levels and improved living standards. In this perspective, a decrease in the prices of crude oil by-products may negatively impact the standard of living in Nigeria.

Furthermore, lower prices could signify economic downturns, reduced government revenue, and potential challenges in sustaining social welfare programs, thereby affecting the overall quality of life. However, the time lag between the impact of government investment on development activities and the impact of increased pump prices of crude oil by-products may harm the standard of living of citizens in the short run.

One major inference that, may be gotten from the above analogies is that, if efforts are made to address the counter-productive effect changes in the prices of crude oil by-products have on the standard of living both in the Nigerian and African context, the African economy's standard of living would increase greatly. It is in an attempt to address this great policy issue that, the current study was rationalized. Again, even when there are myriads of empirical discourse on the topic both in and outside the Nigerian context (10, 19, 22-25), studies on how changes in crude oil by-products affect the standard of living are relatively few. Still, most of the existing studies are faced with methodological issues (14, 19). These huge knowledge gaps also informed the need for the

study. Similarly, the study stands out among the crude oil fluctuation studies by decomposing crude oil by-product price movements is disaggregated into costs of oil price per barrel, diesel pump price, petroleum pump price movements, and kerosene pump price on per capita income. Consequently, the hypothetical model is presented in Figure 1.

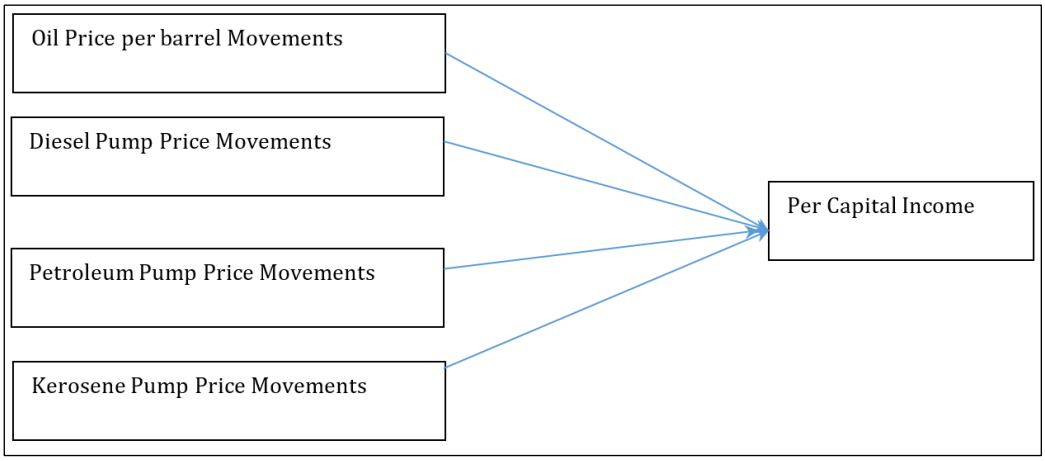

Figure 1: Researchers' Conceptual Framework

The novel research contributes to the ongoing debates on the need for oil-producing countries to develop a more robust framework using revenue generated from crude oil. Again, this study makes a valuable contribution to the extant empirical discourse on crude oil price product influence on a country's development by providing a more robust economic policy model that addresses the linkage between crude oil by-products and the standard of living with emphasis on the Nigerian context. Consequently, the current study provides national, international and global views on the current clamour of economic analysts for a more sustainable source of energy.

Another area wherein the current study deviated from extant empirical discourse lies in the method used. The study unlike previous empirical discourse introduced the fully modified model as the main method of analysis. As such, the study was able to provide a superior model that can be used to predict the extent to which crude oil by-product price fluctuation affects the standard of living in Nigeria. To the researchers' best knowledge, the current study is among the few studies that, examine the linkage between how crude oil by-product variations affect the standard of living in the Nigerian, context. Because most developing countries (Nigerian inclusive) depends solely on crude oil and its by-products and also seek efficient ways of generating revenue away from oil rationalize the need for the study. In addition, it was established that the economic situation in Nigeria can improve if the revenue generated from the sale of crude is well invested in infrastructure development, in the real sector, and if the price of kerosene is reduced. Then the standard of living measured will improve in Nigeria.

The study has some policy implications both in and outside the Nigerian context. First, the model developed in this study would provide a deeper understanding of the consequences of over-reliance on mono-source of revenue especially in the African context. Meanwhile, from the global view, the study would be of great significance to global crude oil policymakers in addressing the counter-productive effect crude oil by-product fluctuations affect the macroeconomic dynamics of the global economy. Being a domestic economic issue, the study would provide a pedestal for the clarification of the issues which surround crude oil by-product changes. By providing an efficient and robust econometric model that captures the linkage between the standard of living and crude oil by-products, policymakers in the Nigerian context can use such information to develop an efficient economic framework that addresses the multiplier effect changes in prices of global and domestic crude oil by-products. Again, such policies will be targeted at improving the per capita income of the Nigerian populace.

The paper covers five main sections. The first section is the introduction; the second section focuses mainly on an in-depth appraisal of extant empirical documentation with emphasis on

theories and a review of existing empirical literature; section three focuses extensively on the data source, model and methodology alongside the nomenclature of variables. Summarily, section four provided robust empirical findings based on the regression presented. Meanwhile, section five concluded the study including findings with various policy implications deduced from the findings.

Methodology

The secondary data for this study fall under the quantitative category covering observation periods of years spanning from 1989 and 2021. Hence, the Ex-post facto research design was adopted. Meanwhile, the data which pertains to the regressors(vectors of crude oil price movements) such as costs of oil price per barrel, the diesel pump price, petroleum pump price and kerosene pump price movements and data of the regressed and or endogenous variable: (standard of living) (per capita income) were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin (26) and the World Bank (27). Specifically, data on the regressed were sourced mainly from CBN Statistical Bulletin, Statisca (2) and OPEC Annual Reports (28) for various years.

The major reason for including these vectors of crude oil by-product prices in the model is because of the crude oil-induced economic conditions prevalent among most Nigerian families, primarily stemming from the fluctuations in crude oil by-product prices. Again, the continuous rise in the domestic pump price of premium motor spirits may elevate production costs and would, lead to a reduction in output if sustained. Similarly, unprecedented movements of prices have caused economic hardship for Nigerians because it forms a single and highly valued commodity as a primary source of exposing and weakening their meagre earning. For crude oil by-product-dependent consumers, price fluctuations are the main sources of economic uncertainties, deepening poverty and diminishing the standards of living (21). Table 1 gives a highlighted explanation of each indicator.

Table 1: Variable Measurement

S/N	Denotation	Measurement	Apriori Expectation
1	PCI	National Income /Total Population.	Nil
2	OPBM	Annual changes in OPBM	Negative (-)
3	DPPM	Annual changes in D	Positive (+)
4	PPPM	Annual changes in PPPM	Negative (-)
5	KPPM	Annual changes in KPPM	Positive (+)

Unlike most extant empirical documentation, the paper applied and conducted two categories of econometric tests: Preliminary tests, and main estimation techniques. The preliminary tests include descriptive statistics, unit not and the co-integration tests. The two main econometric models employed in this study are FMOLS, GMM, and Granger Causality tests (2). The FMOLS model is utilized to estimate the long-term relationships between oil by-product prices (OPBM, DPPM, PPPM, KPPM) and per capita income, which serves as a proxy for the standard of living. This method corrects for endogeneity and serial correlation. The GMM technique further addresses endogeneity and improves estimation efficiency by using instrumental variables. The Granger Causality test is applied to investigate the direction of causality between oil by-product prices and per capita income. This ensures that the model captures both direct and reverse causality effects. This is paramount for the purposes of forecasting.

First, the t-statistic was obtained without stationary or I(0) terms; the OLS estimates are quite consistent. Despite the OLS' exceptional consistency, finite samples have a low convergence rate when there is a large finite sample bias; Second, since the residual captures the dynamics that are left out, OLS estimates may be subject to serial correlation and Heteroskedasticity problems (4). Consequently, it would be incorrect to draw valid empirical conclusions using the normal asymptotically determined parameters. Being a non-parametric approach, FMOLS proffers a solution to the problem of serial correlation. However, the t-statistics of OLS estimates are meaningless when the model is faced with serial correlation and Heteroskedasticity problems (24); and third, FMOLS adds the leads and lags to handle endogeneity issues. Also, FMOLS uses white

heteroskedastic standard errors unlike conventional OLS estimates (25).

Furthermore, econometrically, the study adopted the models of earlier scholars (14), which examined the movements of pump prices and patterns of the standard of living, and which evaluated the effect of crude oil price fluctuations on economic growth in Nigeria (4). The hybrid /modified model is stated thus:

$$PCI = +\beta_0 + \beta_1 OPBM + \beta_2 DPPM + \beta_3 PPPM + \beta_4 KPBM + \mu \ldots\ldots [1]$$

Where:

PCI = Per Capita Income;

OPBM- Oil Price Per barrel Movements, DPPM- Diesel Pump Price Movements, PPPM- Petroleum Pump Price Movements, KPPM- Kerosene Pump Price Movements, ß1, ß2, ß3 ß4 are parameters to be estimated; ß0 = a Constant μ = error terms.

The FMOLS Form is presented as:

$$\begin{aligned} \Delta LPCIt = \theta 0 &+ \sum_{i=1}^{t} \theta_1 \Delta LPCI_{t-1} + \sum_{i=1}^{t} \theta_2 \Delta LOPBM_{t-1} + \sum_{i=1}^{t} \theta_3 \Delta LDPPM_{t-1} + \sum_{i=1}^{t} \theta_4 \Delta LPPPM_{t-1} \\ &+ \sum_{i=1}^{t} \theta_5 \Delta LKPPM_{t-1} + \lambda 1 LPCI_{t-1} + \lambda 2 LOPBM_{t-1} + \lambda 3 LDPPM_{t-1} + \lambda 4 LPPF_{t-1} \\ &+ \lambda 5 LKPPM_{t-1} + \varepsilon t - -3.2 \ldots\ldots\ldots [2] \end{aligned}$$

To further ensure that, our regression estimate is robust, the FMOLS is re-estimated and first-differenced using the GMM technique (dynamic econometric model). The J-statistic was used to determine if the data fit well. Meanwhile, the Granger causality test was introduced to test for the direction of causality between crude oil price fluctuations and the standard of living in Nigeria. Econometrically, the GMM economic form is stated as:

$$\begin{aligned} PCI_{it} &= \alpha_{it} + \sum_{i=1}^{h+d} \beta 1 it FOPP_{it-I} + \sum_{i=1}^{h+d} y_{i_{it}} DPPF_{it-j} + \sum_{k=1}^{c+d} \Delta 1_{it} PPPF_{it-k} + \sum_{w=1}^{v+d} \varepsilon_{1_{it}} KPPF_{it-w} + \varepsilon_1 it \\ FOPP_{it} &= \alpha_{2it} + \sum_{i=1}^{l+d} \beta 2 it PCI_{it-J} + \sum_{i=1}^{h+d} y_{2_{it}} FOPP_{it-j} + \sum_{k=1}^{c+d} \Delta 2_{it} DPPF_{it-k} + \sum_{w=1}^{v+d} \varepsilon_{1_{it}} PPPF_{it-w} + \varepsilon_2 it \\ DPPF_{it} &= \alpha_{3t} + \sum_{i=1}^{h+d} \beta 1 it PCI_{it-1} + \sum_{i=1}^{h+d} \beta_{3_{it}} FOPP_{it-J} + \sum_{k=1}^{c+d} y3 DPPF_{it-k} + \sum_{w=1}^{v+d} \varepsilon_{1_{it}} PPPF_{it-w} + \varepsilon_3 it \\ PPF_{it} &= \alpha_{4it} + \sum_{w=1}^{v+d} \varepsilon_{1_{it}} PCI_{it-w} + \sum_{i=1}^{C+d} \Delta_{4_{it}} FOPP_{it-j} + \sum_{k=1}^{c+d} \beta 4_{it} DPPF_{it-I} + PPPF_{it-j} + \varepsilon_4 it \ldots\ldots [3] \end{aligned}$$

The possibility of reverse causality and omitted variable bias was addressed by incorporating the Granger Causality Test, instrumental variables in the GMM model and introduced Ramsey Reset Test (RRT). To address potential reverse causality between oil by-product prices and per capita income, this study incorporated the Granger Causality Test, which helps to establish the direction of causality. Additionally, GMM is employed to mitigate the risk of omitted variable bias by using lagged values of the independent variables as instruments. This ensures that any potential feedback loop from changes in per capita income to oil by-product prices is accounted for, thereby improving the reliability of the results. Also, the RRT further ensure that the model is well-specified. Prequel to conducting the preliminary test main regression estimate, various preliminary tests were conducted. First, data gathered were subjected to a time series (unit root) test. Time series data are prone to several issues including producing spurious estimates (i.e. due to the presence of unit root) and if not addressed would affect the reliability of the regression estimate. To avoid spurious outcomes, the Philip Peron (PP) Unit Root test was employed. The decision rule of the PP test (PP) is that, the null hypothesis with a

p-value above 5% and Critical value at 5% greater than the T-statistics suggests non-stationarity. However, if its p-value is below 5% and its critical value at 5% less than the T-statistic value, the alternative hypothesis in support of stationarity is accepted instead. The Im, Pesaran test form is presented as:

$$yi, = \beta i + \gamma i yi, -1 + \varepsilon i, t.$$

The two testable forms are:

$$H_0: = \delta = 0 \text{ (Unit Root)}$$

$$H_1: = \delta \neq\neq 0$$

Other preliminary tests considered are the normality test for testing if the series is normally distributed or not; the Heteroskedasticity test for determining if the residual of the series spreads evenly (Homoskedastic) or unevenly (Heteroskedastic); Ramsey Reset test for determining whether or not any of the variables were omitted, and the models mis-specified.

Results and Discussion

This section elucidates the research findings in tandem with extant empirical findings. Specifically, this section began with the results of various preliminary tests to ascertain the model that best fits the study before the main regression model is presented. This is with the intent to present the policy implications of each finding.

Preliminary Test

Table 2 displays the results of the descriptive statistics related to the variables employed in this study and includes typical measures of central tendencies, such as the mean and median, as well as measures of variability, including the minimum, maximum, and standard deviation, for five different variables: OPBM, DPPM, PPPM and KPPM. These statistics provide a clear representation of the historical performance of these indicators during the years studied.

Table 2: Results of Descriptive Statistics

	PCI	OPBM	DPPM	PPPM	KPPM
Mean	1410.179	51.77606	55.32545	49.12136	54.44061
Median	1250.410	40.76000	21.40000	40.00000	24.00000
Maximum	3200.950	116.8800	225.0900	145.9200	290.7500
Minimum	270.0300	14.14000	0.350000	0.390000	0.300000
Std. Dev.	933.6720	35.56265	67.02987	46.65996	75.63545
Skewness	0.277612	0.631743	1.229211	0.687661	1.880666
Kurtosis	1.588075	1.902374	3.400124	2.378057	5.770515
Jarque-Bera	3.164986	3.851626	8.530417	3.132695	30.00714
Probability	0.205462	0.145757	0.014049	0.208806	0.000000
Sum	46535.91	1708.610	1825.740	1621.005	1796.540
Sum Sq. Dev.	27895790	40470.47	143776.1	69668.87	183063.1
Observations	33	33	33	33	33

The PCI showed maximum and minimum values of USD3200.950 and USD270.0300 respectively with an average of US1410.179. Also, diesel pump prices deviated from the mean by 55.32545 and 67.02733 with the highest and least fluctuations of 225.09 and 0.30 respectively. Also, KPPM changed by 75.63545 with a mean of 54.44061 and maximum and minimum values of 290.75 and 0.20, respectively; this indicates that KPPM deviates a great deal away from the mean when compared to the other variables. The values of the standard deviation for all indicators showed that their averages are clustered appropriately. The Jarque-Bera test for each of the variables gives an idea of the distribution of each of the variables in the model. Where the value of the JB test is low, the p-value suggests that the data is not normally distributed. The result is interpreted based on the p-values provided. Since most of the variables have P-values >0.05 it is an indication that the model is distributed normally. The Jarque-Bera test for normality (Figure 2) presents a clearer picture.

To establish that the data used for this study was normality distributed, so the result of the study could be used for further inferences, the normality test was carried out. The Jarque-Bera test aims to test whether the distribution of the residuals in the regression model follows a normal distribution. The results of the Kurtosis indicate that for DPPM and KPPM the values are greater than 3, implying that is more peaked than the normal curve (that is, leptokurtic). But for PCI, OPBM, and PPPM the values are less than 3, meaning that their curves are less peaked than the normal curve (that is

platycurtic). The residuals in the regression model are normally distributed at 0.05. The results of the test are presented in Figure 2. From the figure, it can be inferred from the P-value (0.626854)>0.05. The residuals in the OLS regression model followed a normal distribution. Furthermore, they are positively skewed (from the skewness value of 0.324457).

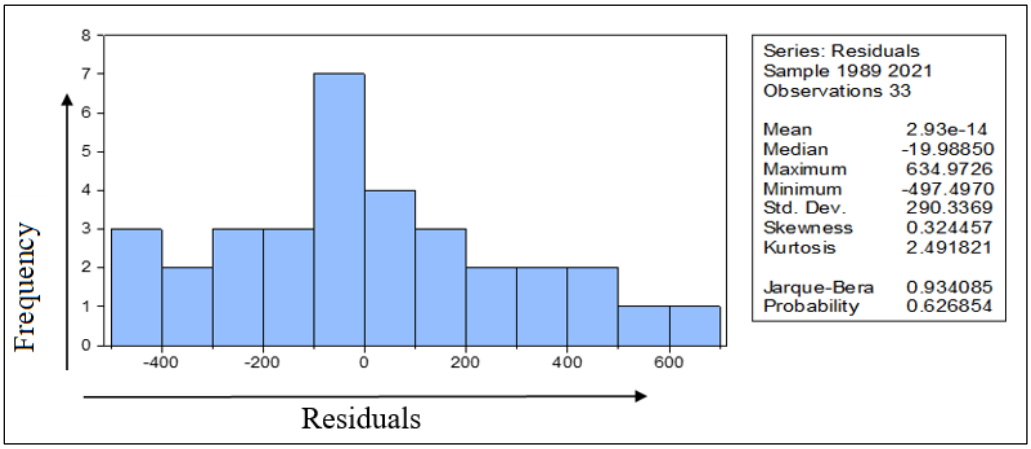

Figure 2: Jarque-Bera Test of Normality for Residuals

Figure 2 represents the normality test results for the residuals from the OLS regression model, highlighting the p-value and skewness. The result in Table 3 showed that datasets were not stationary at the level since the PP t-statistics was lower than its critical values at 5% level but attained stationary (no unit root) at first-difference I(1). By implication, the dataset did not exhibit issues of non-stationarity. This justifies the need to further test if the datasets are cointegrated or not. However, PCI, OPBM, DPPM PPPM, and KPPM are stationary at first difference (I(1)).

Table 3: Unit Root Test

Variables	T-statistics	Critical value at 5%	Order of Integration	Bandwidth
PCI	-3.932062	-2.960411	I(1)	1
OPBM	-14.80696	-2.960411	I(1)	1
DPPM	-5.384250	-2.960411	I(1)	0
PPPM	-5.531824	-2.960411	I(1)	1
KPPM	-3.963354	-2.960411	I(1)	1

The Johanson cointegration test was introduced having evidenced that, the datasets are stationary (4). The statistical result evidenced that, datasets are cointegrated. Therefore, the H0 in support of no cointegration was rejected. Thus, the data set affirmed that the data sets are co-integrated at significant levels.

From Table 4, to test if the series exhibits a long-run relationship or not, the Johansen cointegration test was conducted after confirming that the datasets are stationary (4). The statistical results showed that the datasets are cointegrated. Hence, the null hypothesis (H0) of no cointegration was rejected. This affirmed that the data sets are co-integrated at significant levels. This implied that crude oil price fluctuations have a long-run effect on the standard of living and quality of life in Nigeria within the periods covered.

Table 4: Results of the Long Run (Johansen Cointegration) Test

		Trace	0.05	
	Eigen-value	Statistic	Critical Level	Prob.**
R=0	0.8333	94.0149	69.8189	0.0002*
R=1	0.6059	54.4145	47.8565	0.0107**
R=2	0.3488	20.2360	29.7979	0.4069
R=3	0.2000	6.9368	15.4947	0.5850
R= 4	0.0006	0.0190	3.8415	0.8901

Cointegrating Equations (R=0, R=1, R=2, etc.)

Legend:

- Critical values for 1% significance level: 6 9.8189
- Critical values for 5% significance level: 4 7.8565
- Significant at 1% level: R=0
- Significant at 5% level: R=1

Regression

Having confirmed that the series is stationary at first difference {1(1)} and are cointegrated, for the main regression estimates presented here, we estimated the OLS, FMOLS and GMM models' Granger causality. They are discussed thus: the FMOLS reported an adjusted R-squared of 0.903302, changes showing that GO Percent variations in PCI are explained by the changes and fluctuations in OPBM, KPPM, DPPM and PPPM and explained 90% of the aggregate change in the standard of living, while other stochastic variables account for the remaining 10%. The auto-correlation-free nature of the model is shown by the Durbin-Watson (DW) statistics of (1.587666) which is not too far from the benchmark of 2. The explanatory variables had a joined and significant effect on the quality of living throughout the period under investigation, as shown by the F-statistic p-value of 0.0000. The model further evidenced the absence of autocorrelation between the variables in the empirical model. Also, the Ramsey Reset test and the ARCH tests both evidenced that the model is well specified and the residuals are Homoskedastic evidencing that the model is robust and fit for prediction/policy formulation. The study thus established that OPBM has a negative coefficient of -0.2826 (prob. value of 0.028); this suggests that changes in COP per barrel have a positive significant effect on living standards. The typical standard of living in Nigeria would increase by USD16 for every one-unit rise in COP per barrel. As an oil-producing nation, where the economy largely depends on oil export, an increase in COP per barrel can have several impacts on the standard of living. Higher oil prices lead to increased government revenue, as oil is a significant source of income through export earnings and taxes. This revenue can be used to ascertain infrastructure projects, public services, and social programs resulting in higher standards of living as portrayed in this result. Also, the oil sector's growth can stimulate other sectors of the economy, leading to increased employment opportunities and overall economic growth resulting in to increase in PCI of the citizens. The results support the findings of earlier researchers in this field (10, 14). They confirmed that the standard of living in Nigeria rises and falls in tandem with the country's reliance on petroleum products like Premium Motor Spirit (PMS), Automotive Gas Oil (AGO), and Dual Purpose Kerosene (DPK). This justifies the low cost of living between 1981 and 2019 (4). However, some researchers reported that changes in COP had only a minimal impact on the Nigerian economy (22).

The coefficient of DPPM0.0102 and the P-value is 0.1637. By implication, a one-unit increase in DPPM will result in a USD1.02 increase in PCI. Generally, it is unusual for an increase in DPPM to directly lead to an increase in PCI in Nigeria or any other country. Typically, an increase in fuel prices can contribute to inflationary pressures and higher costs for businesses and consumers, potentially impacting PCI negatively. However, indirectly, if an increase in diesel pump prices is associated with a broader increase in international COP, it could lead to higher revenue from oil exports. If the government effectively manages and allocates this additional revenue to development projects, it might stimulate economic growth, and job creation, and ultimately contribute to higher PCI. This appears to be the case in Nigeria as shown by the result.

The result showed that PPPM coefficient is -0.4170 and the P-value is 0.0437. This shows a negative significant impact of PPPM. This is equally supported by expectations, and the analysis made in PPPM against PCI also holds. This Result suggests that the higher the petrol pump price fluctuates, the lower the PCI. That is, PPPM has a high adverse effect on the standard of living of the average Nigerian. This result corroborates with findings of other researchers in the field (18). They evidenced that, changes in petroleum pump price have a highly detrimental effect on the Nigerian economy. The policy implication here is that the more the price of motor spirit (PMS) rises, the more the standard of living falls. Justifiably, the current rise in PMS to 1200.

The coefficient of KPPM is negative as expected although the P-value of -0.0237 shows that it is negligible at 0.05 level of significance. As mentioned earlier, an increase in KPPM can contribute to inflationary pressures and higher

costs for businesses and consumers, potentially impacting PCI minimally. Moreover, the poor who are the majority use kerosene. In a nutshell, the results indicate that while diesel pump price movements (DPPM) and kerosene pump price movements (KPPM) had negligible effects on per capita income, oil price per barrel (OPBM) and petrol pump price movements (PPPM) had significant impacts. The minimal effect of DPPM and KPPM could be attributed to the fact that these fuels are not the primary drivers of consumer expenditure in Nigeria. In contrast, OPBM and PPPM have more direct effects due to their significant role in government revenue and household expenditure, as higher petrol prices directly affect transportation costs and inflation. This aligns with previous studies (10, 17).

Table 5: FMOLS Regression

Parameters	**Coefficients**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	10.5581	0.5137	20.5542	0.0000*
OPBM	-0.2826	0.0852	-3.3157	0.0028*
DPPM	0.0102	0.0071	1.4350	0.1637
PPPM	-0.4170	0.1971	-2.1159	0.0437**
KPPM	-0.0237	0.1123	0.2111	-0.8345
AR(1)	0.9950	0.0339	29.3381	0.0000*
Model Diagnostic Tests				
R^2	0.9033	Adjusted R^2		0.8895
Prob(F-statistic)	0.0000	Durbin-Watson stat		1.5876
ARCH Test	0.3950	Serial Correlation Test		0.3205
Ramsey Reset Test (RRT)				0.9628

Note: * and ** denotes significant at 1% and 5% level

The results of the FMOLS model estimate the long-term impact of each oil by-product price (OPBM, DPPM, PPPM, KPPM) on PCI (Table 5). Significant variables are marked, and the Durbin-Watson statistic indicates the absence of autocorrelation in the model. Also, the RRT with p-value of 0.9628 suggests that, the model is not mis-specified. Hence, the issue of variable mis-specification was addressed.

To further ensure that, our regression estimate is robust, the FMOLS is re-estimated and first-differenced using the GMM technique (dynamic econometric model) as presented in Table 6. This model lagged both the regressed and regressors (instrumental variables). The J-statistic value of 0.0000 confirms that the model fits the data well.

As presented by the model, the incessant rise in oil prices by barrel and petroleum pump prices is the reason behind the low standard of living. The study confirmed that past values of petroleum pump price (ΔLPPPM) and oil price per barrel (ΔLPPPM) reduce past values of PCI by a significant value of 69.75% and 34.09%, respectively. However, past values of kerosene and diesel pump prices have an inconsiderable/minimal effect on past values of PCI. By implication, if the Nigerian policymakers direct their attention towards addressing the counter-productive effect OPBM and PPPM have on the standard of living of her citizenry, the Nigerian economy would develop significantly.

Table 6: GMM Estimate

Dependent Variable: ΔLPCI				
Parameters	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	2.1291	0.1591	13.3815	0.0000*
ΔLOPBM	-0.3409	0.0880	-3.8728	0.0006*
ΔLDPPM	0.0868	0.1046	0.8296	0.4141
ΔLPPPM	-0.6975	0.0094	-7.4428	0.0000*
ΔLKPPM	0.0282	0.0575	0.4901	0.6280
R^2	0.8895	Adj. R^2		0.8772
Durbin-Watson stat	2.1440	J-statistic		0.0000

The GMM model shows the dynamic relationship between past and present values of the oil by-product prices and PCI. Significant coefficients for OPBM and PPPM are highlighted, showing how past values of oil price per barrel and petrol prices influence the current standard of living. Table 7 results confirm that a bi-directional relationship exists between OPBM and PCI and PPPM and PCI with causality from DPPM Granger causes PCI. This further suggests that a rise in OPBM causes changes in PCI and that, changes in PCI cause more demand for crude oil by-products. It is in this regard that, the null hypotheses in support of no causality are rejected. In like manner, the study confirmed that a rise in PPPM causes changes in PCI and, that, changes in PCI cause more demand for crude oil by-products. However, uni-causality flows from PCI to KPPM and from DPPM to PCI. By implication, changes in kerosene and diesel pump prices are not attributable to the current level of income in the economy by implications the Nigerian economy. The results of the KPPM and DPPM cum PCI indicated that fluctuations in the prices of kerosene and pump price of diesel are income-yielding and income-generating. If attention is targeted at improving the standard of living in Nigeria, much revenue would be generated from kerosene and diesel pump prices.

Table 7: Results of Pairwise Granger Causality Tests

Testable Forms	Obs.	F-Statistic	Prob.	Decision
OPBM>PCI	32	10.9566	0.0027*	OPBMGranger causes PCI
PCI <OPBM		4.05999	0.0303**	PCI Granger causes OPBM
DPPM> PCI	32	3.72705	0.0389**	OPBMGranger causes PCI
PCI < DPPP		1.10452	0.3026	No causality
PPPM> PCI	32	5.24027	0.0301**	PPPMGranger causes PCI
PCI <PPPM		3.72705	0.0389**	PCI Granger causes PPPM
KPPM> PCI	32	0.22575	0.6385	No Causality
PCI <KPPM		4.86708	0.0101**	KPPMGranger causes PCI

Note: > denotes does not Granger Cause while < denotes the reverse order of >; *,*, and **** denotes 1%, 5%, and 10% significant level

Results of the Granger Causality Test

The Granger Causality Test reveals the directional causality between the variables. OPBM Granger-causes PCI, meaning that changes in oil price per barrel predict changes in PCI. Similarly, PPPM Granger-causes PCI, while no causality is found for KPPM and DPPM. By implication, that changes in petrol only case changes in the standard of living but changes in the standard of living does not result to changes in price of petrol. The aforementioned findings align with overarching economic development ideas such as the resource dependency theory and the resource curse theory. First, the resource dependency theory stresses on how resource-rich countries like Nigeria are often vulnerable to economic hardship due to volatility in global oil market. The reason behind that is that most of the resource-rich countries like Nigeria do not diversify their economic resource. As a result, they become highly sensitive to changes in oil prices. By implication, if the oil by-product moves falls, the standard of living will fall also and vice versa. Second, the resource course theory further revalidated the claims of the resource dependency theory. The theory stressed that countries with less natural resources grows faster than resource-rich countries due to deindustrialization and a narrow economic base, corruption and poor governance, conflict over control and distribution, economic unrest, neglect of human capital. Again, over reliance on oil exports inflates the domestic currency, reduces the competitiveness of other sectors like agriculture and manufacturing. To mitigate these effects, Nigeria must adopt policies that diversify its economy, investing in sectors that generate sustainable long-term growth, such as technology, manufacturing, and renewable energy. By reducing its reliance on oil, Nigeria can stabilize its economy and improve the standard of living for its citizens in the long term.

Conclusion

This study analyzed the effects of the changes in the prices of crude oil by-products on living standards in Africa, with a focus on Nigeria between 1989 and 2021. Crude oil price changes were disaggregated into the fluctuation of the costs of OPBM, DPPM, PPPM and KPPM and regressed on per capita income (a proxy for living standards) in Nigeria. The data were analyzed using econometric

methods, specifically the Philip-Peron (PP) Unit Roots test and the fully and the GMM. The research established OPBM that, OPBM and DPPM had a positive and significant effect on PCI while PPPM and KPPM, had an insignificant effect on the increases in the prices of selected crude oil by-products. Such as KPPM and DPPM tend to improve the income status (by implication) standard of living of the citizens. This is possible because the increase in the price usually Granger causes PCI (The vector for income). This usually results in excess crude oil revenue to both government and economic agents. Government expenditure from this excess revenue necessitates the effect of the pump prices and its harsh effects on citizens. The increased prior empirical research indicates that the impoverished state of the Nigerian economy is due to over-reliance on crude oil. It is important to mention that Kerosene has a favorable effect but its effect is statistically insignificant. The study concludes that the overall reliance on crude oil is the reason behind the improvised state of the Nigerian economy. The findings suggest significant policy ramifications for Nigeria. First, there is an urgent need for policies aimed at enhancing domestic refining capacity to reduce dependence on imported refined products. This would stabilize the price of oil by-products and shield the domestic market from global crude oil price fluctuations. Second, the government should consider revising the abrupt removal of fuel subsidies as abrupt removal distorts the market and exacerbates inflation. Instead, subsidies could be gradually phased out while promoting alternative energy sources, such as solar or hydropower. Lastly, policies aimed at diversifying the economy away from oil dependency, such as investing in manufacturing and agriculture, would help mitigate the long-term effects of oil price volatility on the standard of living. The present study has some limitations that suggest areas for future research advancement. Firstly, the study was limited to the Nigerian economy. Therefore, future research should encompass other OPEC member countries, especially crude oil by-product-dependent economies and, a more empirically disaggregated econometric model should be estimated.

The results of this study align with broader economic development theories such as dependency theory, which suggests that resource-rich countries like Nigeria are often dependent on volatile commodity markets, making their economies vulnerable to external shocks. The findings also touch on the concept of Dutch disease, where a reliance on oil exports inflates the domestic currency, reducing the competitiveness of other sectors like agriculture and manufacturing. To mitigate these effects, Nigeria must adopt policies that diversify its economy, investing in sectors that generate sustainable long-term growth, such as technology, manufacturing, and renewable energy. By reducing its reliance on oil, Nigeria can stabilize its economy and improve the standard of living for its citizens in the long term

Abbreviation

Nil.

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Author Contributions

Dr. Ighoroje Ese James: wrote the introduction, review of literature and methodology while Dr. Egberi Kelvin Agbarha analyzed, and interpreted the data and wrote the conclusion. Dr. Okorie Chiyere: sourced data, and assisted in writing the conclusion and reference.

Conflict of Interest

The authors declared that there are no conflicts of interest regarding the publication of the manuscript.

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