Nigeria's Downstream Petroleum Industry Supply Chain and Distribution Network and the Implications on Pump Prices

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***Abstract*—This study analyses Nigeria's downstream petroleum industry supply and distribution network and examines its implications for Premium Motor Spirit (PMS) pump prices across the country's six geopolitical zones and the Federal Capital Territory (FCT). Using a quantitative ex-post facto research design, the study employs secondary time-series data covering 2014–2023, sourced from the Nigerian National Petroleum Corporation (NNPC) and the Department of Petroleum Resources. Descriptive statistics, regression analysis, and trend (rate-of-change) analysis were applied to evaluate the relationship between PMS supply volumes and pump price variations. Findings reveal significant regional disparities in PMS distribution, with the South-South and South-West zones accounting for the largest average supply volumes. Empirical results show that pump price variations exhibit a weak but positive relationship with PMS supply in most regions, while a statistically significant relationship exists only in the South-West zone. Trend analysis indicates that the average rate of change in PMS supply across all regions is positive, confirming increasing supply trends despite rising pump prices. The results suggest that pump prices alone do not fully explain supply dynamics, as infrastructure constraints, logistics costs, and policy interventions play critical roles. The study concludes that Nigeria's uniform pump pricing regime inadequately reflects regional distribution costs, contributing to economic distortions. Policy recommendations emphasize the need for empirically driven, region-sensitive petroleum pricing and supply strategies to enhance market efficiency, stabilize inflation, and support sustainable economic growth.**

***Keywords*—downstream-petroleum-sector, supply-chain-network, economic-implications, pump-prices**

I. Introduction

The downstream petroleum sector supply chain and distribution network in Nigeria consist of a network (linked group) of the refineries (though none functional over the period under review), the licensed petroleum product importers cum product tank farm operators, the major and independent petroleum product markets who source products from the government licensed importers. The interactions between and among these groups in the product distribution chain have implications on energy cost (pump prices), commodity price inflation, per capital income, etc., across the geopolitical zones and regions (Nwokedi, Okoroji, Nze, and Ndukwu, 2015).

Shipping oil trade and distribution (import, export and local trading of petroleum resources) is viewed as the exchange of petroleum resources (crude oil and refined oil resources) to and from demand and supply markets (locations) in varied geographical locations, in the local and international market. It entails the sourcing (Bahgat, 2008), purchasing and carriage and/or transportation by sea using ocean going tankers vessels; and the local distribution of the refined products using bulk road vehicles. The composition and interaction between the demand and supply sources of petroleum resources, and the local distribution links to hinterland locations within the six geopolitical zones and 36 states of Nigeria and the Federal Capital Territory, Abuja, give rise to the supply chain and distribution network of petroleum resources, in Nigeria. It is important to note that the supply chain and distribution network of petroleum product in Nigeria, have implications on the operational cost of both the upstream and downstream sectors of the petroleum industry in Nigeria (Bahgat, 2008; Igbalajobi & Eniola, 2023).

The upstream sector of the petroleum industry comprise of the offshore and onshore operations involved in the exploration, drilling and subsequent transportation to refineries of crude oil resources using vessels of various kinds and forms, ranging from Exploration vessels and tanker vessels; to drilling Floating Production Storage and Offloading Systems (FPSO'S) and crude oil pipelines (Faruk & Tijjani, 2023). The downstream sector of the petroleum industry commences from the bulk movement of refined petroleum resources from the refineries to the hinterland demand centers in the 36 states of Nigeria and the geopolitical zones, including the Federal Capital Territory, FCT, Abuja.

According to the Council of Logistics Management (2008), Logistics is that part of the supply chain process that plans, implements and control the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and

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the point of consumption in order to meet customers' requirements. In an industry such as the shipbuilding and repair characterized with its global nature, a critical analysis of its logistics nature is essential to give a competitive edge to the local industry in Nigeria.

Strategic analysis of supply chain and logistics network of market commodity types is usually designed to achieve optimal operational cost, increase client service level and maximize profit. In the downstream petroleum industry for example, a supply chain and logistic network analysis would be necessary to investigate and compare the operational cost and delay implications of varied supply and demand sources, with a view to achieving optimal price levels, and subsequently reduce inflation in prices of market commodities and improve productivity employment and income of citizens (Gbadebo, 2008; Nneji & Nwosu, 2022).

For example, prior to the commencement of the fuel subsidy regime in Nigeria, there exist about three refineries in Nigeria with responsibilities to source crude oil resources from the National Petroleum Corporation (NNPC) in the upstream sector, refine and distribute to the various demand markets in Nigeria. The supply chain and logistics network of petroleum resources before the advent of the petroleum subsidy regime is demonstrated in Fig. 1 below:

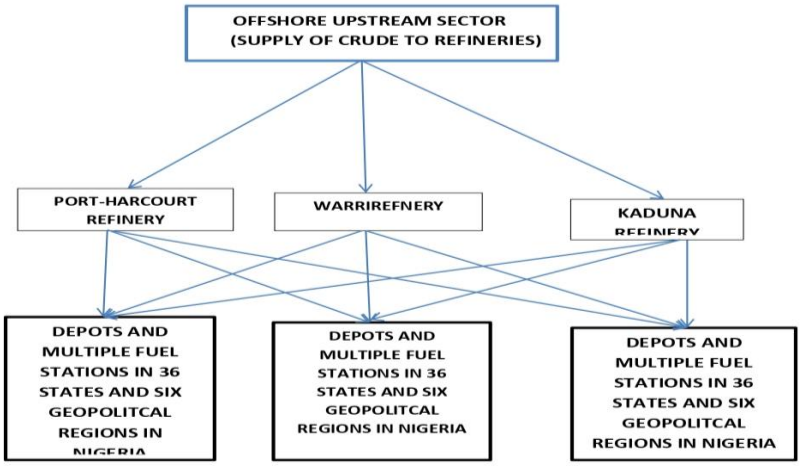

Fig. 1. Supply chain network of downstream petroleum industry from offshore drilling locations to refineries and from refineries depots in the geopolitical zones and retails stations in Nigeria.

Following the failure and non-functioning of the refineries and subsequent licensing of operators to engage in the import of refined petroleum products for local use in Nigeria; the supply chain and distribution network was altered and the refineries play minor roles in the import and distribution chain. Product tank farms located in various coastal terminals in Lagos, Port-Harcourt, Delta, Calabar and other coastal zones in Nigeria import and distribute to hinterland demand markets in the 36 states in the geopolitical zones. See Fig. 2 below:

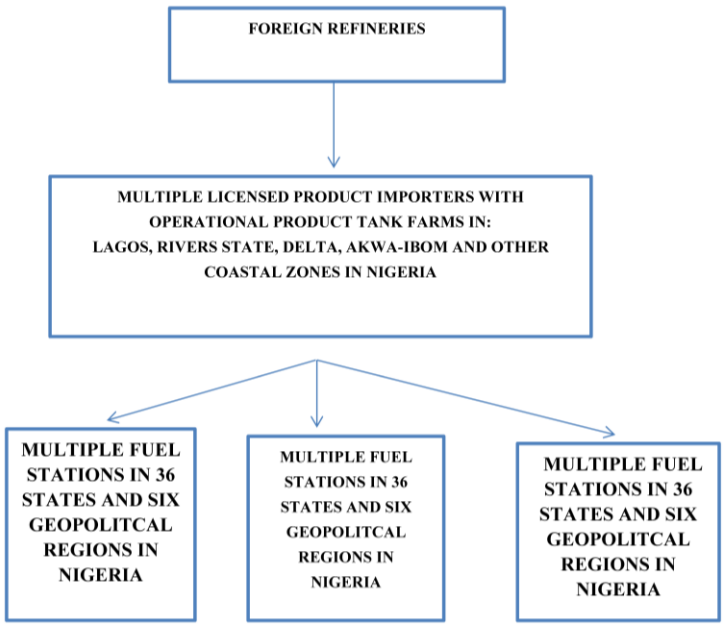

Fig. 2. Supply chain network of downstream petroleum industry from offshore drilling locations to refineries and from refineries depots in the geopolitical zones and retails stations in Nigeria. Source: Prepared by the author.

The regional petroleum Deports were also eliminated in the new supply chain and distribution network that emerged following the failure of the refineries to produce and the emergence of the fuel importation system regime. Notwithstanding the emergence of a new supply and distribution network in the downstream sector of the petroleum industry and the petrol import regime which saw competing firms importing and marketing petroleum products, the Federal Government continues to fix uniform pump prices across the distribution network and zones across Nigeria.

The implications is that it is difficult to have a petroleum product pricing regime that reflects the real logistics and transportation cost implications of the supply of the products across the supply chain and distribution network in Nigeria. These have subsequent implications on the levels of engagement in productive activities, unemployment rate, public income, output levels and inflation on commodity prices in Nigeria (Nwokedi *et al.,* 2015).

This study therefore seeks to analyze the downstream petroleum industry supply chain and distribution network in Nigeria with a view to providing empirical evidences of its relationship with product pump prices, as well as examine the dynamics of product supply across the geopolitical regions and states in Nigeria

The objectives of the study are:

(1) To investigate the relationship between supply of petroleum products and pump prices in the geopolitical zones of Nigeria.
(2) To estimate the coefficient of rate of change showing the trends of product supply to the geopolitical regions associated with variations in pump prices over the years.

The research questions addressed in the study include:

(1) Is the relationship between supply of petroleum products and pump prices in the geopolitical zones of Nigeria significant?
(2) What is the coefficient of rate of change of product supply of products to the geopolitical regions associated with variations in pump prices in Nigeria?

The study addressed the following hypotheses

H_{01}: There is no significant relationship between supply of petroleum products and product pump prices in the geopolitical zones of Nigeria.

H_{02}: The coefficient of rate of change of petroleum product supply to the geopolitical regions associated with variations in pump prices in Nigeria is indeterminate.

II. Literature Review

Onyemechi *et al*. (2017) did a study on the assessment the contributions of the ocean economy of Nigeria to the development of national economy. The study noted the contribution of nation to the new strategy for frontier states adjacent to the coastal region for the improvement of their position in the efficiency frontier curve, especially with regards to energy supply. The continuity of a coastal state to remain a leader in the production and efficiency frontier curve of modern day development will thus depend on their ability to sustainably develop their most strategic economic resource base such as the energy resources.

The Nigerian downstream petroleum sector is characterized by a network comprising refineries, licensed importers, tank farm operators, and marketers. Historically, three domestic refineries sourced crude from the upstream sector to distribute products through regional depots. However, the failure and non-functioning of these refineries necessitated a shift toward a fuel importation regime (Adedeji & kehinde, 2022; Akinpelu & Ogbari, 2023).

In the current altered network, petroleum products are imported through coastal terminals in locations such as Lagos, Port Harcourt, Delta, and Calabar. These products are then distributed via bulk road vehicles to hinterland markets across the 36 states and the Federal Capital Territory (FCT). A significant finding of the study is that the regional petroleum depots were largely eliminated following the collapse of domestic refining (Nwokedi, 2026; Eniola & Ikpefan, 2022; Bahgat, 2008).

Available empirical studies mostly used survey approaches to investigate the extent of satisfaction of end-users with the current refined petroleum products distribution and supply chain networks marked by preponderance of importers and distribution challenges. The use of quantitative research approaches employing real-time supply and consumption data is seeming lacking. The national average volume of PMS distributed annually during this period between 2010 and 2023 was approximately 3.38 billion liters (Nwokedi, 2026; Eniola & Ikpefan, 2022).

There is a seeming disconnection between the logistics costs of the distribution network and the government's uniform pricing policy creates economic distortions. These distortions contribute to commodity price inflation, unemployment, and reduced public income. Findings from available empirical studies suggest that because energy pricing influences consumption costs across all geopolitical zones, it must be addressed to stabilize the economy. This can be achieved through:

(1) Ensuring that pricing policies are based on empirical data regarding how price changes affect supply and consumption.
(2) Using regulation to ensure that authorities develop policies ensuring price and supply stability to prevent the destabilization of industrial production.

According to Olayungbo and Ojeyinka (2021),the downstream petroleum industry in Nigeria encompasses the refining, distribution, storage, and marketing of refined petroleum products such as Premium Motor Spirit (PMS), automotive gas oil (diesel), and kerosene. Historically dominated by state-owned entities such as the Nigerian National Petroleum Company (NNPC), the sector has seen persistent inefficiencies due to moribund refineries and inadequate distribution infrastructure, leading to heavy reliance on imported products to meet domestic demand (PMC, 2014; Olayungbo & Ojeyinka,

2021). PMC (2014) opined that since the downstream supply network involves depots, pipelines, and road haulage systems that connect refineries and import terminals to end-user retail outlets; efficient depot operations are integral to stabilizing supplies nationwide; disruptions within this network often translate to regional fuel shortages and price volatility (PMC, 2014)

Studies by Olayinka and Ojenyinka (2021) consistently shown that distribution inefficiencies are a core driver of supply disruptions and pricing dynamics in the sector. Transport and logistics constraints—such as poor road infrastructure, checkpoint delays, and breakdowns—inflate cost components within the supply chain, resulting in higher landed costs of petroleum products and longer delivery lead times.

The malfunction of domestic refineries historically compounded these issues. Four refineries with a nameplate capacity of 445,000 barrels per day were producing well below capacity, forcing massive importation of refined products (PMC, 2014). This structural weakness meant that the downstream distribution network often served as the choke point: limited product availability at depots triggered scarcity at retail outlets, pushing pump prices upward and triggering public outcry (PMC, 2014).

Studies by Abdullahi, Nteegah and Kalu (2024) and Adamu (2025) agree that Nigeria's downstream prices reflect a combination of international oil price pass-through effects, exchange rate fluctuations, and domestic sector reforms. Empirical research using econometric techniques like Autoregressive Distributed Lag (ARDL) models has shown that international crude prices and macroeconomic variables significantly influence retail petroleum prices over time (Abdullahi, Nteegah & Kalu, 2024; Adamu, 2025). Specifically, Abdullahi *et al*. (2024) found a long-run relationship between petroleum product prices and general price levels in Nigeria, indicating that refined product pricing has broader inflationary implications. Similarly, Adamu (2025) highlighted that both crude oil prices and exchange rate movements significantly determine Premium Motor Spirit pricing, with differing short-run sensitivities between state-linked and private refinery sources.

Beyond macroeconomic drivers, policy reforms such as deregulation and subsidy removal have shifted the distribution of risks and costs onto market operators and consumers. Empirical work examining deregulation outcomes suggests that while deregulation can attract investment and improve sector efficiency, it may also correlate with rising pump prices and inflationary pressures if not accompanied by infrastructure and regulatory improvements (Amechi *et al*., 2025; Ogunleye & Olanipekun, 2023).).

Recent structural changes—most notably the commissioning of the Dangote Petroleum Refinery and attempts to introduce regulatory reforms like targeted import duties—offer empirical evidence of evolving supply network dynamics. Domestic refining capacity has begun displacing a portion of imported products, reducing supply chain leakage and foreign exchange exposure; however, challenges in crude supply, regulatory consistency, and external shocks continue to affect domestic product availability and pricing (Amechi *et al*., 2025).

For instance, while a planned import duty intended to support local refining capacity would have increased pump prices marginally, pushback from marketers resulted in the policy's cancellation—highlighting the supply–price tension between promoting local refining and maintaining retail affordability (Amechi *et al*., 2025). Reuters (2025) observed that additionally, the Dangote refinery's capacity to deliver near-national demand levels has been subject to dispute, with implications for distribution costs and pricing stability wherever supply constraints emerge.

Collectively, these findings underscore the complex interplay between distribution network efficiency and pricing outcomes in Nigeria's downstream petroleum industry.

From the various empirical literatures reviewed, the following literature gaps are identified in line with the objectives of the study:

There is a seeming lack of empirical knowledge of what constitute the extent of the relationship between supply of petroleum products and product pump prices across the product supply chain and distribution network, in the geopolitical zones of Nigeria significant. The lack of this information has hindered optimal pump price formation that reflects market demand and supply conditions across the product distribution network in Nigeria. Similarly, the knowledge of what constitute the coefficient of average rate of change of product supply to distribution networks in the geopolitical regions and variations in pump prices in Nigeria in currently lacking in available empirical literature. These are the gaps which the current study is seeking to address.

III. Data and Methods

The study area of the research is the Nigeria downstream petroleum industry supply chain and distribution network, regulated by the Nigeria National Petroleum Corporations, the Department of Petroleum Resources (DPR) and other agencies of government in the sector. Thus, the distribution of petroleum products to the six geopolitical zones of Nigeria, encompassing the 36 states and the federal Capital Territory, Abuja was implemented in the work. Therefore, the study area of the research is the Nigeria downstream petroleum industry distribution and supply chain network across the geopolitical zones in Nigeria.

In this study, it is a public opinion and belief, advanced in available empirical literature that the pump prices and costs associated with the distribution of petroleum products through functional supply chain networks to the regions and geopolitical locations (markets) where they are consumed have influences of product pump prices, product availability and overall output of the economy. So, per liter prices of petroleum products set by the Central Government in the implementation of her duty to

regulation operations in the sector, consequently affects commodity prices in the markets across the geopolitical zones, in varied proportions. This is because with central distribution points/depots, the marketers travel disproportionate destinations' depending on the locations of the fuel stations in the geopolitical zones. This has implications on energy cost, production cost and other economic parameters in the geopolitical zones.

Thus, it is a generally accepted philosophy that the benchmark for determining the extent of the effects of variations in pump prices over time on the economy is to investigate what constitute the trend of economic parameters in the economy relative to the trend of increases in per liter prices of petroleum products in the economy over time.

In line with the positivism research philosophy used in this study, this study used the deductive research approach. This is because the deductive research approach is best suited for positivism research philosophy which demands the use of quantitative data from observations or measurement.

The study used a quantitative and ex-post facto research design in which quantitative data was obtained from secondary sources and used for carrying out the study. Time series quantitative data covering a period of 10 years from 2014 to 2023 was used. The dataset include data on the quantity of Premium Motor Spirit (PMS) supplied annually through the distribution chain to each geopolitical region and state in Nigeria (***SUP$_P$***) and pump price per liter (***PUPR$_L$***) in each year over the period, as identified in the objectives of the study. Each dataset covered a period of 10 years as already explained.

This research relied entirely upon secondary data for the study. Secondary data constitute of data generated from secondary means such as annual statistical report of the Nigeria National Petroleum Corporation, Central bank of Nigeria Statistical Bulletin, Journal publications, website and data base of related organizations, etc. The data used for the study was sourced from the various secondary sources. For example, data for the quantity of petrol supplied (***SUP$_P$***) through the product distribution network to the states, geopolitical zones and FCT Abuja and the prevailing annual pump prices per liter (***PUPR$_I$***) was sourced from the Department of Petroleum resources and NNPC annual statistical reports.

The data collected for the study was analysed by the use of both descriptive and inferential statistics. Furthermore, a variant of the regression method, that is, the trend analysis method in which time serves as the explanatory variable was also used to analyse the data obtained in order to address the second specific objectives of the study aimed at determining trends and average rate of change coefficients of the variables.

For the first objective of the study, the relationship between product supply through the distribution network to each geopolitical zone and pump prices will be estimating using:

$$SUP_P = \beta_0 + \beta_1 PUR_I + \mathcal{E} \quad (1)$$

For the second objective of the study, the average rate of change of product supply through the distribution network to each geopolitical zone as a result of changes in product pump prices was also estimated using Eq. (1). The hypotheses will be tested by using the respective F-test and t-test corresponding to the estimated models. The study used Microsoft excel software to implement the analysis.

IV. Results and Discussion

Table I above shows the average quantity of PMS supplied and distributed to the various geopolitical regions per annum between 2014 and 2023. The result indicates that respective averages of 3.32E + 08 liters, 1.29E + 09 liters, 1.95E + 08 liters, 2.69E + 08 liters, 1.9E + 08 liters, 8.9E + 08 liters, and 2.13E + 08 liters of PMS were distributed to the South-East (SE), South-South (SS), North-East (NE), North-Central (NC), North-West (NW), South-West (SW) and FCT Abuja per annum between 2014 and 2023 with respective standard deviations of 12898572, 4.67E + 08, 32846929, 14397074, 26241094, 65443822 and 16085401.

TABLE I. Average Distribution, Supply and Consumption of Premium Motor Spirit (PMS) to Geopolitical Regions in Nigeria between 2014 and 2023

Statistics	*SE (Ltrs)*	*SS(Ltrs)*	*NE (Ltrs)*	*NC (Ltrs)*	*NW(Ltrs)*	*SW(Ltrs)*	*FCT (Ltrs)*
Mean	3.32E + 08	1.29E + 09	1.95E + 08	2.69E + 08	1.9E + 08	8.9E + 08	2.13E + 08
Standard Error	12898572	4.67E + 08	32846929	14397074	26241094	65443822	16085401
Median	3.35E + 08	6.82E + 08	2.21E + 08	2.72E + 08	1.82E + 08	8.74E + 08	2.21E + 08
Mode	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Standard Deviation	40788867	1.48E + 09	1.04E + 08	45527545	82981626	2.07E + 08	50866504
Sample Variance	1.66E + 15	2.18E + 18	1.08E + 16	2.07E + 15	6.89E + 15	4.28E + 16	2.59E + 15
Kurtosis	−1.17651	1.353169	−1.8716	−1.56768	−1.64778	−1.06336	−1.34094
Skewness	−0.11003	1.731663	−0.33058	−0.2375	0.142912	0.39933	−0.35249
Range	1.26E + 08	3.82E + 09	2.52E + 08	1.25E + 08	2.21E + 08	6.06E + 08	1.39E + 08
Minimum	2.67E + 08	3.82E + 08	52629202	1.96E + 08	87700001	6.28E + 08	1.41E + 08
Maximum	3.93E + 08	4.2E + 09	3.05E + 08	3.21E + 08	3.08E + 08	1.23E + 09	2.8E + 08
Sum	3.32E + 09	1.29E + 10	1.95E + 09	2.69E + 09	1.9E + 09	8.9E + 09	2.13E + 09
Count	10	10	10	10	10	10	10
Confidence Level (95.0%)	29178598	1.06E + 09	74304917	32568443	59361479	1.48E + 08	36387705

Source: Author's calculation.

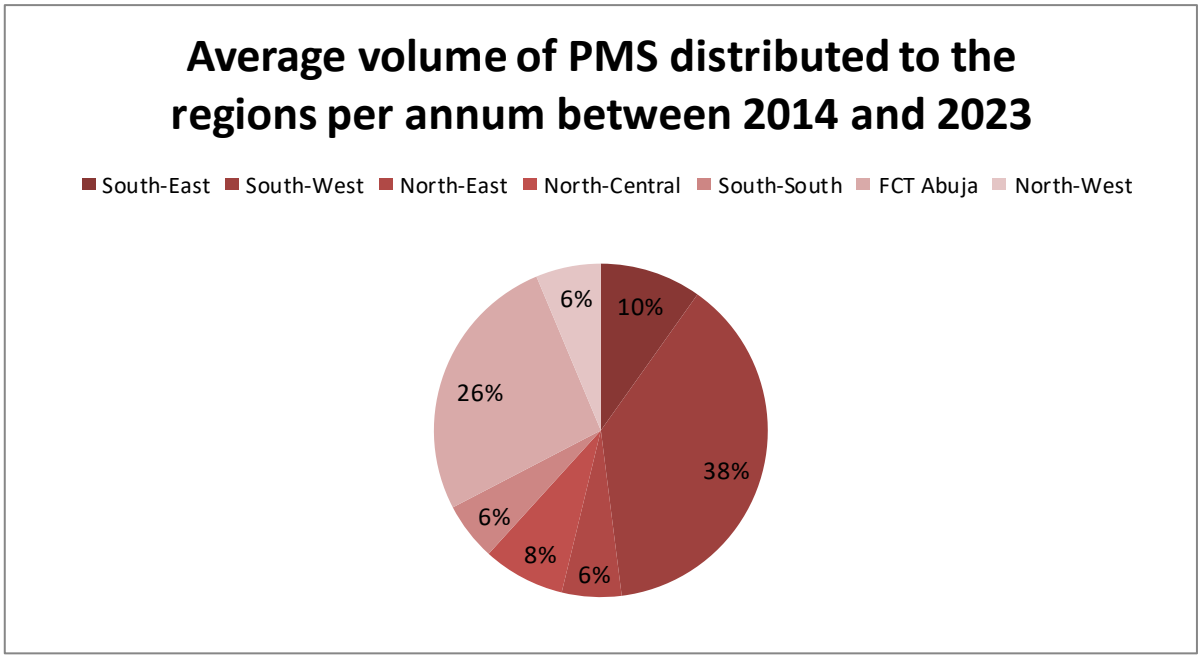

Fig. 3. Average volume of PMS distributed to the regions per annum between 2014 and 2023. Source: Prepared by the author.

The aggregate volumes of PMS distributed to each of the six geopolitical zones and the FCT Abuja over the 10 years period covered in the study from 2014 to 2023 are 3.32E + 09 liters, 1.29E + 10 liters, 1.95E + 09 liters, 2.69E + 09 liters, 1.9E + 09 liters, 8.9E + 09 liters, and 2.13E + 09 liters respectively for each of South-East (SE), South-South (SS), North-East (NE), North-Central (NC), North-West (NW), South-West (SW) and FCT Abuja regions. Fig. 3 shows presentation of the pictograph evidencing the average volume of PMS distributed to each region per annum over the period.

The result of the study shown in Table II above indicates that the national average volume of PMS distributed in the domestic market in Nigeria per annum between 2014 and 2023 is 3.38E+09 billion liters with stand deviation of 1.41E+09 liters. The aggregate volume of PMS distributed in the local market in Nigeria over the 10 years period in the study is 3.38E+10 billion liters.

TABLE II. NATIONAL AVERAGE DISTRIBUTION AND SUPPLY OF PMS PER ANNUM BETWEEN 2014 AND 2023

Statistical Measure	Value
Mean	3.38E + 09
Standard Error	4.45E + 08
Median	3.16E + 09
Mode	#N/A
Standard Deviation	1.41E + 09
Sample Variance	1.98E + 18
Kurtosis	0.239061
Skewness	0.9929
Range	4.18E + 09
Minimum	1.82E + 09
Maximum	6E + 09
Sum	3.38E + 10
Count	10
Confidence Level (95.0%)	1.01E + 09

Source: Author's calculation

TABLE III. RELATIONSHIP BETWEEN THE DISTRIBUTION CUM SUPPLY OF PMS AND PER LITER PRICES IN THE GEOGRAPHICAL REGIONS IN NIGERIA BETWEEN 2014 AND 2023

Geopolitical Zones/Regions	Constant Term (s) β_0	Regression Coefficient β_1	t-score	*p*-value/sign	Multiple R	R Square
South-East	2.98E + 08	168657.1	2.055714	0.07385	0.5879	0.3457
SOUTH-SOUTH(SS)	1.56E + 09	−1377896	−0.37899	0.714559	0.32805	0.107637
NORTH-EAST (NE)	1.25E + 08	350698.5	1.547842	0.16025	0.480062	0.23046
NORTH-WEST (NW)	1.2E + 08	352439.4	2.142951	0.064479	0.49563	0.24731
SOUTH-WEST (SW)	6.91E + 08	996759.7	2.658106	0.02889	0.684826	0.468986
NORTH-CENTRAL (NC)	2.82E + 08	−62639.8	−0.56423	0.588065	0.536431	0.286685
FCT	1.79E + 08	172464.1	1.556341	0.158239	0.482087	0.232408
National	3.26E + 09	600482.7	0.171994	0.867713	0.610697	0.372984

Source Prepared by the author's.

Table III above is the result showing the relationship between the distributions cum supply of PMS in the various geopolitical zones in Nigeria and the variations in pump prices per liter of product distributed. The Table III above is used to actualize the first objective of the study and it also addressed the first research question established in chapter one of this study.

The result shows that coefficient of correlation between the supply cum distribution of PMS to the South-east geopolitical zone over the period covered in the study is 0.587. This indicates that about 59% weak,

but positive correlation exist between the distribution cum supply of PMS to the South-East region and the variations in PMS pump prices per liter over the period.

The equation showing the empirical relationship between the distribution/supply of PMS to the South-east and changes in pump prices per liter over the period is:

$$SUP_{PSE} = 2.98E+08 + 168657.1PUR_I \quad (2)$$

Eq. (2) above implies in the South-east region, for each unit increase in PMS prices of PMS per liter, supply and distribution of PMS to the region increased by 168657.1 liters over the period from 2014 to 2023 covered in the study. This implies that notwithstanding the increase in per liter price of PMS over the period, supply and distribution of the product in the region still increased over the period. This is in line with the laws of supply of markets goods and services which proposes that product suppliers cashes in on increased prices to deliver more volumes of the product to the consumers in the markets. However, the R-square coefficient which measures the explanatory power of the model is approximately 0.35, suggesting that only 35% variation in volume of PMS supplied and distributed in the South-east region is explained by variations in pump prices of the product. Other factors such as the demand for the product among other may be responsible for the remaining.

In the South-South geopolitical zone, the coefficient of determination of the relationship between the supply of PMS to the region and the changes in pump prices of PMS over the period is 0.32805. This indicates the existence of about 33% positive, but weak correlation between the volumes of PMS supply and distributed in the region and the changes in pump prices per liter of the product over the period covered in the study.

The mathematical relations between supply cum distribution of PMS and pump price in the South-South regions (Eq. (3)):

$$SUP_{PSS} = 1.56E+09 - 1377896PUR_I \quad (3)$$

This implies that over the 10 years period covered in the study, a unit increase in the pump price of PMS is associated with 1,377,896 units decline in the volume of PMS supplied to the regions. This suggests that demand for PMS declines in the South-South regions over the period following increase pump prices per liter of the product. The r-square coefficient which measures the explanatory power of the model is 0.108. This implies that only a paltry 11% variation in the supply and distribution of PMS to the South-South region is influenced by changes in pump prices. Factors other than price are responsible for about 89% remaining variations in the supply and distribution of PMS to the region.

In the North-East region, the result of the study shows a 48% correlation between the volume of PMS supplied in the region and changes in pump prices per liter consumed over the period. The model depicting the relationship between the volume of PMS distributed in the region and changes in pump prices over the period is (Eq. (4)):

$$SUP_{PNE} = 1.25E+08 + 350698.5PUR_I \quad (4)$$

The implication is that for each 1 naira increase in pump prices per liter of PMS over the period between 2014 and 2023, the volume of PMS supplied and distributed in the North-East increased by 350698.5 liters. This again confirms similarly to the findings in the South-East and south-South region that pump price per liter is not the sole determinant of directions of demand and supply of petroleum products (PMS) in the regions. The r-square coefficient indicates that only about 23% variations in the volume of PMS supplied and distributed in the North-East region is explained by variations in pump prices**.**

In the North-West region, there exist about 49% weak, but positive correlation between the volumes of PMS distributed in the region over the period covered in the study and the changes in the prices of PMS per liter.

Eq. (5) showing the empirical relationship between the supply cum distribution of PMS in the region and the changes in PMS prices per liter is:

$$SUP_{PNW} = 1.2E+08 + 352439.4\mathrm{PUR_I} \quad (5)$$

The implication is that for each 1 naira increase in pump prices per liter of PMS supplied over the period between 2014 and 2023, the volume of PMS supplied and distributed in the North-East increased by 352439.4 liters. The r-square coefficient which measures the explanatory power of the model is 0.25, indicating that a paltry 25% variations in the volume of PMS supplied and distributed in the North-East region is explained by variations in pump prices**.**

In the South-West, the result of the study indicates the existence of about 68% strong positive correlation between the volume of PMS distributed and consumed in the region and the changes in the price per liter of PMS supplied to the regions over the period. The mathematical model showing the influence of variations in pump prices of PMS on the volume of PMS supplied and distributed in the region over the period is:

$$SUP_{PSW} = 6.91E+08 + 996759.7PUR_I \quad (6)$$

By implication, a 1 naira increase in the price per liter of PMS distributed in the South-South region over the period is associated with 996759.7 units increase in the liters of PMS distributed in the region over the 10 years period covered in the study. The coefficient of r-square however indicates that only about 47% variation in volume of OMS distributed in the South-West region is explained by changes in pump prices of the product over the period.

In the North-Central region and the FCT Abuja, the result reveal the existence respective of 54% and 48% positive correlation between volume of PMS distributed and changes in pump prices in each of the North-Central

region and FCT Abuja. The model equations showing the influences of changes in prices per liter of PMS on volumes of PMS distributed in each of the North central region and FCT Abuja are respectively shown below (Eqs. (5) & (6)):

$$SUP_{PNC} = 2.82E+08 - 62639.8PUR_I \quad (6)$$

$$SUP_{PABJ} = 1.79E+08 + 172464.1PUR_I \quad (7)$$

In the North-central region, a 1 naira increase in pump price per liter is associated with a 62639.8 liters decline in the volume of PMS supplied and distributed in the regions while a 1 naira increase in the pump price per liter of PMS in the FCT Abuja is associated with a 172464.1 increase in the volumes of PMS supplied and distributed in the regions over the period covered in the study between 2014 and 2023. The result showing the rate of change and trend of supply and distributing of the PMS in the various geopolitical zones between 2014 and 2023 is shown in Table IV below.

TABLE IV. THE COEFFICIENT OF AVERAGE RATE OF CHANGE SHOWING THE TRENDS OF PRODUCT SUPPLY TO THE GEOPOLITICAL REGIONS FOLLOWING VARIATIONS IN PUMP PRICES OVER THE YEARS

Geopolitical Zones/Regions	Constant Term(s)	Rate of Change coefficient(s) over time (T)	t-score	*p*-value	Multiple R	R-square
South-East	271043183.9	11100581.36	4.1129	0.003377	0.82396697	0.67892
SOUTH-SOUTH(SS)	19517458	−121060283.8	−0.7255	0.48883	0.24845481	0.06173
NORTH-EAST (NE)	12727181.4	33123357.19	10.485	5.96E−06	0.96548446	0.93216
NORTH-WEST (NW)	41222630	27140913.53	20.114	3.9E−08	0.99025772	0.98061
SOUTH-WEST (SW)	518671190.5	67524605.75	17.993	9.34E−08	0.98786846	0.97588
NORTH-CENTRAL (NC)	219598331.6	9010564.436	2.1169	0.067139	0.59921612	0.35906
FCT	127580223.1	15598565.72	7.0696	0.000105	0.92844995	0.86202

Source Prepared by the author's.

Table IV above shows the result of the study on the rate of change and trend of supply and distribution of PMS to the geopolitical zones in Nigeria between 2014 and 2023. The result of the study indicates that the coefficient of average rate of change of the volumes of PMS supplied and distributed in each South-East, South-South and North-East regions over the 10 years covered in the study are 11100581.36 liters, −121060283.8 liters, and 33123357.19 liters. The positive coefficient of the average rate of change of PMS supply and distribution to the regions indicate that while the trend of supply and distribution of PMS to the South-East region and North-East region is increasing by respective averages of 11100581.36T and 33123357.19 per annum over the period; the trend of supply of PMS to the South-South- region is declining by an average rate of −121060283.8 per annum over the period.

The equations of the trend of supply and distribution of PMS in the South-east, South-south and North-east are respectively shown below (Eqs. (8)–(10)):

$$SEPMS_{trend} = 271043183.9 + 11100581.36T \quad (8)$$

$$SSPMS_{trend} = 19517458 - 121060283.8T \quad (9)$$

$$NEPMS_{trend} = 12727181.4 + 33123357.19\text{T} \quad (10)$$

Similarly, the average rate of change coefficients showing the trend of supply and distribution of PMS to the North-west, South-west, North-central and FCT Abuja are 27140913.53 liters, 67524605.75 liters, 9010564.44 liters and 15598565.72 liters respectively with respective coefficients of correlation of 99%, 99%, 60%, and 93% for North-west, south-west, North-central regions and FCT Abuja.

The equations showing the respective trends of supply and distribution of PMS to each of the North-west, South-west, North-central regions and the FCT Abuja are as shown below (Eqs. (11)–(14)):

$$NWPMS_{trend} = 41222630 + 27140913.53T \quad (11)$$

$$SWPMS_{trend} = 518671190.5 + 67524605.75T \quad (12)$$

$$NCPMS_{trend} = 219598331.6 + 9010564.436T \quad (13)$$

$$FCTPMS_{trend} = 127580223.1 + 15598565.72T \quad (14)$$

The implications are that over the 10 years period covered in the study, the trend of supply and distribution of PMS to each of the North-west and South-west region increases by respective averages of 27140913.53 liters and 67524605.75 each year while it increases by respective averages of 9010564.436 liters and 15598565.72 liters for the North-central region and FCT Abuja respectively.

The significances of the increases in the trends of supply and distribution of PMS in the various geopolitical regions in Nigeria is investigated in subsequent sections on the test of hypotheses. Fig. 4 below is the line graph showing the trend of supply and distribution of PMS in the geopolitical regions and the FCT over the period between 2014 and 2023.

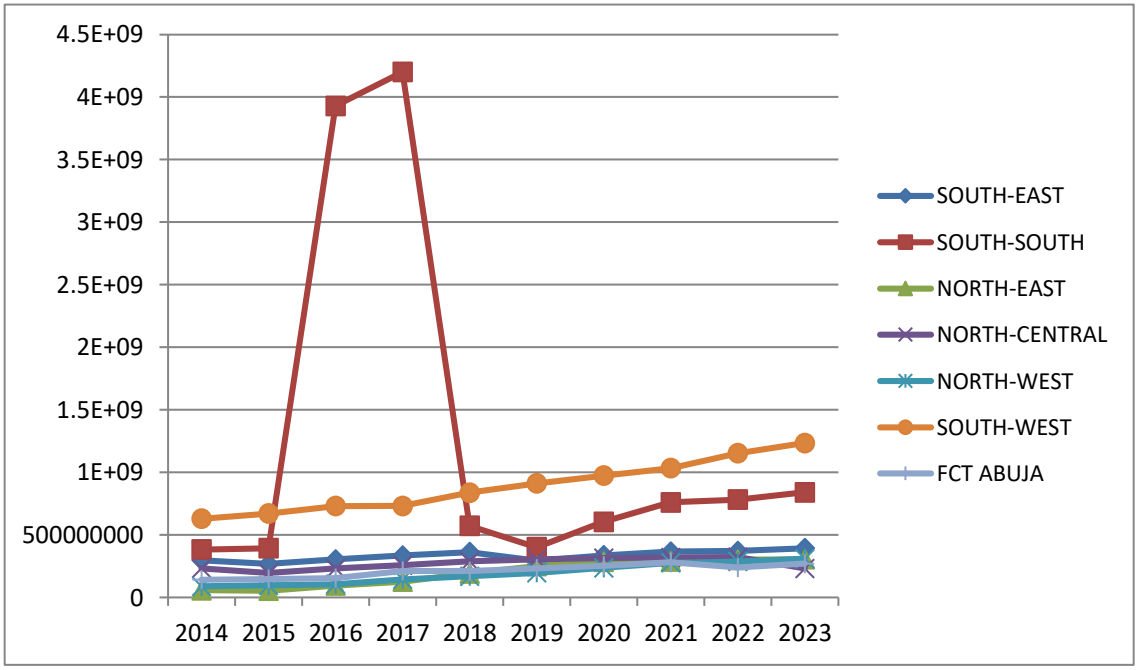

Fig. 4. Trend line of PMS distribution and consumption in Geopolitical zones in Nigeria and the FCT Abuja 2014-2023. Source: prepared by the author.

A. Discussion of Abnormal Supply Fluctuations in the South-South Region

The trend analysis presented in Fig. 4 reveals an abnormal fluctuation in PMS supply volumes within the South-South region between 2016 and 2018. Specifically, PMS supply volumes declined sharply during the period before experiencing rapid recovery afterward. This fluctuation represents a structural deviation from the broader national trend and requires contextual explanation.

The abnormality may be linked to several operational and macroeconomic disruptions that affected Nigeria's downstream petroleum distribution network during the period. First, the Niger Delta region experienced heightened militant activities and attacks on petroleum infrastructure between 2016 and 2017, leading to pipeline vandalism, depot disruptions, and interruptions in petroleum logistics operations. These disruptions reduced operational efficiency within major petroleum supply corridors located in the South-South region.

Second, Nigeria experienced a severe foreign exchange crisis and economic recession in 2016, which constrained the ability of petroleum marketers and importers to access foreign exchange required for importing refined petroleum products. This situation contributed to periodic scarcity and unstable supply patterns across petroleum distribution channels.

Third, transportation bottlenecks, poor road infrastructure, and delays associated with product evacuation from coastal depots may also have contributed to temporary reductions in regional supply volumes. Since the South-South region hosts significant petroleum infrastructure and serves as a critical supply node, operational disruptions within the region can generate disproportionately large fluctuations in observed supply data.

The rebound in PMS supply volumes after 2018 may reflect gradual stabilization in petroleum importation processes, improved security interventions, and restoration of operational activities within the downstream supply chain network.

Although the trend analysis remains useful for understanding long-term regional supply behavior, the observed fluctuation suggests the presence of potential outlier effects capable of influencing regression sensitivity and trend estimation. Consequently, the findings relating to the South-South region should be interpreted cautiously. Future studies may improve robustness by applying outlier-adjusted estimation techniques, structural break analysis, or robust regression methods to further validate the stability of the observed relationships.

Table V above shows the result of the test of hypothesis H_{01} which reveal that in the South-west region, the *p*-value is less than the alpha value ($0.02889 < 0.05$); there the study infer that in the south-west region, there is significant relationship between supply of petroleum products and product pump prices. In all the other remain five regions and the FCT Abuja, the result of the study reveal that the *p*-value is greater than the alpha value of 0.05.

TABLE V. H01: THERE IS NO SIGNIFICANT RELATIONSHIP BETWEEN SUPPLY OF PETROLEUM PRODUCTS AND PRODUCT PUMP PRICES ACROSS THE GEOPOLITICAL ZONES OF NIGERIA

Geopolitical zones/regions	t-score	*p*-value/sign	Decision
South-East	2.055714	0.07385	0.07385>0.05, Accept H_{01a}
SOUTH-SOUTH(SS)	−0.37899	0.714559	0.714559>0.05, accept H_{01b}
NORTH-EAST (NE)	1.547842	0.16025	0.16025>0.05; Accept H_{01c}
NORTH-WEST (NW)	2.142951	0.064479	0.064479>0.05; Accept H_{01d}
SOUTH-WEST (SW)	2.658106	0.02889	0.02889<0.05; Reject H_{01e}
NORTH-CENTRAL (NC)	−0.56423	0.588065	0.588065>0.05; Accept H_{01f}
FCT	1.556341	0.158239	0.158239>0.05; Accept H_{01g}
National	0.171994	0.867713	0.867713>0.05, Accept H_{01h}

Source: Author's calculation. Note: Accept H_{01} if *p*-value>0.05 alpha value; Reject H_{01} if *p*-vale<0.05 alpha value.

TABLE VI. H02: THE COEFFICIENT OF RATE OF CHANGE OF PETROLEUM PRODUCT SUPPLY TO THE GEOPOLITICAL REGIONS ASSOCIATED WITH VARIATIONS IN PUMP PRICES IN NIGERIA IS INDETERMINATE

Geopolitical zones/regions	Rate of change coefficient(s) (β_1)	Decision
South-East	11100581.36	11100581.36>0, Reject H_{02a}
SOUTH-SOUTH(SS)	121060283.8	121060283.8>0; Reject H_{02b}
NORTH-EAST (NE)	33123357.19	33123357.19>0; Reject H_{02c}
NORTH-WEST (NW)	27140913.53	27140913.53>0; Reject H_{02d}
SOUTH-WEST (SW)	67524605.75	67524605.75>0; Reject H_{02e}
NORTH-CENTRAL (NC)	9010564.436	9010564.436>0; Reject H_{02f}
FCT	15598565.72	15598565.72>0; Reject H_{02g}

Source Prepared by the author's. Note: if β1 >0; Reject H02; if β1 <0, Accept H02.

The test of Hypothesis H_{02} shown on Table VI reveal that in all the geopolitical zones in the Country and the FCT Abuja, the coefficient of rate of change of PMS supply to the zones relative to variations in pump prices is greater than zero (ie: $\beta_1>0$). The study therefore infers that the coefficient of rate of change of petroleum product supply to the geopolitical regions associated with variations in pump prices in Nigeria is greater than zero.

The hypothesis test results presented in Table V reveal substantial regional variation in the relationship between PMS supply volumes and pump prices across Nigeria. At the 5% significance level, only the South-West region exhibited a statistically significant relationship between PMS supply and pump prices ($p = 0.02889 < 0.05$). In contrast, the remaining geopolitical zones and the FCT showed statistically insignificant relationships.

This finding suggests that the influence of pump prices on PMS supply is not uniform across Nigeria's downstream petroleum distribution network. Rather, the relationship appears to be region-specific and shaped by broader structural and operational conditions. The South-West region, which accommodates major petroleum import terminals, storage facilities, and the country's highest commercial consumption centers, demonstrates stronger responsiveness between supply volumes and price movements than other regions.

The statistically insignificant relationships observed in the South-East, South-South, North-East, North-West, North-Central, and FCT regions imply that factors beyond pump prices substantially influence PMS supply dynamics in these regions. Such factors may include transportation infrastructure, depot accessibility, road network quality, insecurity, distribution bottlenecks, supply chain disruptions, regulatory interventions, and regional consumption behavior.

Therefore, the study does not claim a universally significant national relationship between PMS supply and pump prices. Rather, the findings indicate that the Nigerian downstream petroleum market exhibits regional heterogeneity, where pump price effects are moderated by logistical and structural realities unique to each region.

B. The Impact of Pump Price Variations on PMS Supply and Economic Indicators

The research findings presented in the study offer valuable insights into the intricate relationship between pump price fluctuations; PMS supply volumes, and various economic indicators in Nigeria. The analysis, spanning from 2014 to 2023, revealed distinct regional patterns and significant implications for the country's economy.

The implication is that to achieve a functional economy where inflation is less pronounced and rampant, unemployment is addressed and moderate, output is optimized in tune with prevailing economic realities and consumer prices are moderately comfortable for majority of the population; energy pricing which influences energy consumption cost and the supply across Nigerian geopolitical zones and regions must be addressed

A key observation is the differential response of PMS supply volumes to pump price changes across different geopolitical zones. While the South-West region exhibited a pronounced sensitivity to price variations, other regions, including the FCT Abuja, demonstrated a less pronounced or even insignificant correlation. This suggests that factors beyond pump prices, such as regional demand dynamics, infrastructure constraints, and policy interventions, play a crucial role in determining the responsiveness of supply in these areas.

The study identified significant regional disparities in the supply and distribution of PMS. for example, there exist:

(1) Volume Differences: The volume of PMS distributed varied significantly across regions,

with some regions receiving substantially more than others.

(2) Price Sensitivity: The responsiveness of supply to price changes differed across regions, suggesting varying levels of price sensitivity. The correlation between supply and distribution and pump prices varied across regions, indicating different underlying factors influencing supply dynamics.

(3) Elasticity of PMS Supply

The study's calculation of the average rate of change in PMS supply volumes relative to pump price changes indicates that the elasticity of supply is greater than unity. This implies that a given percentage increase in pump prices leads to a proportionally larger increase in supply volumes. Such an elastic response suggests that producers are relatively responsive to price signals and are willing to expand production in response to higher prices.

The study's analysis highlights the significant impact of petroleum product supply and pump price variations on commodity price inflation in Nigeria. The findings suggest that fluctuations in the supply and pricing of PMS have a substantial influence on the broader inflationary trends within the country. This underscores the critical role of the petroleum sector in driving price pressures and influencing the overall cost of living.

V. Conclusion

In conclusion, the research findings provide valuable insights into the complex interplay between pump prices, PMS supply, and economic indicators in Nigeria. The study's regional analysis highlights the diverse responses of supply volumes to price changes, while the broader implications on the country's economic landscape.

In the South-West region, increasing trend in the pump prices of PMS has significant effects of the extent of variations in the volumes of PMS supplied to the regions between 2014 and 2023. The result and findings of the study indicates that only about 47% variation in volume of OMS distributed in the South-West region is explained by changes in pump prices of the product over the period. The result is different in the other regions and the FCT Abuja where increasing trend in the pump prices of PMS has effects on the volumes of the products supplied to the regions, though not significantly.

The average rate of change in volumes of PMS supplied to the geopolitical zones in Nigeria associated with variations in pump prices is greater than unity.

Variations in PMS supply volumes and pump price trends in Nigeria exhibit regionally differentiated economic implications. However, the empirical findings suggest that pump prices alone do not significantly explain PMS supply behavior in most regions, indicating that broader logistical, infrastructural, and institutional factors remain critical determinants of downstream petroleum distribution dynamics in Nigeria.

Study Limitations: This study relied on aggregated regional time-series data covering the period 2014–2023. Consequently, certain operational variables capable of influencing PMS supply dynamics—such as transportation costs, depot efficiency, pipeline vandalism, regional insecurity, foreign exchange volatility, and inventory shortages—were not explicitly incorporated into the regression models. Additionally, abnormal fluctuations observed in the South-South region between 2016 and 2018 may have influenced trend estimation outcomes. Therefore, the findings should be interpreted within these analytical boundaries. Future studies are encouraged to apply robustness testing techniques and disaggregated operational datasets to improve estimation precision.

Recommendations: Increase in PMS pump prices affects the volumes of PMS supplied and available for consumption in the geopolitical zones. This has consequences on the economy. It is therefore recommended that policies for petroleum product pricing and price determination for the local economy must first provide empirical information on how these new prices affect product supply, consumption and economy implications on the local economy before it is implemented. This empirical information will serve as guide to develop strategies for mitigating the negative effects of increasing trend in products pump prices in Nigeria.

Lastly, Government and regulatory authorities should develop policies that ensure stability in the pricing of petroleum products and its supply across the industrial estates and zones in Nigeria in order to ensure that industrial productions are not destabilize following disruptions of pricing and supply of petroleum product.

Conflict of Interest

The authors declare no conflict of interest.

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