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A Vector Error Correction Model of Petrol Price Transmission and Sectoral Price Dynamics in Nasarawa State, Nigeria (2020–2025)

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Abstract

This study examined petrol price transmission and sectoral price dynamics in Nasarawa State, Nigeria, within the period 2020–2025. The study used consumer price of premium motor spirit (PMS), commonly known as petrol, as the measure of petrol price, while the price indicators for food prices (FPI), transport (TPI), and kerosene (KPI) were used to measure sectoral prices. The study employed the Vector Error Correction Model (VECM), supported by appropriate pre-estimation and post-estimation tests. The findings revealed two cointegration equations and revealed the existence of long-run equilibrium relationship between the variables, while Error Correction Term (ECT) coefficients reveals that (ECT_1= -0.2186) carries a negative sign and is significant at 5 % level, which indicates that 21.86 % of any short-run shocks to long-run balance are adjusted within one period while (ECT_2= -0.2181) is negative and significant which implies that 21.81 % of disequilibrium in the system is corrected. The recommendations among others is that, government and private sectors should stipulate policies that promote domestic refining capacity and market stability to mitigate excessive price transmission effects across sectors.

Keywords: Error correction term (ECT), Petrol price transmission, Sectoral prices, Vector error correction model (VECM)

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Introduction

The period between 2020 and 2025 in Nasarawa State, and in the rest of Nigeria, was characterized by significant economic trauma driven by the drastic increase in petrol price which skyrocketed in 2024 onwards with high inflationary pressures, and severe increase in cost-of-living. Premium Motor Spirit (PMS), usually referred to as petrol, is a refined product obtained from crude oil. Crude oil was discovered in Oloibiri, which is in Bayelsa State today, in January 1956, which marks the inception of the petroleum industry in Nigeria [1]. Nasarawa State, being one of the rapidly developing states in North Central Nigeria, has witnessed significant increases in food prices, an increase in transportation prices, and other sectoral price indicators between 2020 and 2025. In this study, emphasis is placed on key sectors that directly affect individuals' welfare in Nasarawa State, such as food, transport, and kerosene prices.

Food prices represent changes in the prices of essential food items and are particularly important in developing economies where a large number of households' income is spent on food consumption. Food price increase or inflation remains a major menace to the well-being of individuals and households in many developing nations, an example of which is Nigeria. It is often influenced by import costs and logistics [2]. According to the NBS [3], the food inflation rate rose to 37.77 % in September 2024, up from the corresponding month in the previous year, reflecting a substantial increase in food prices. The NBS (2024) also reported that food inflation in Nigeria averaged 13.72 % between 1996 and 2024, highlighting persistent fluctuations in food prices. During this period, the highest food inflation rate of 40.87 % was recorded in June 2024, while the lowest rate of -17.50 % was observed in January 2000 NBS [3]. Similarly, the World Bank estimated that the speedy increase in inflation and food prices in Nigeria contributed to an additional seven million people falling into poverty in 2020 [4]. At the state level, data released by the National Bureau of Statistics publicized that Nasarawa State remained among the states with the highest food price indicators in Nigeria throughout 2025, placing considerable financial stress on households [5]. The report showed that food inflation in the state stood at 33.53 % on a year-on-year basis in February 2025 and, although it declined, remained considerably high at 22.74 % by October 2025 [5].

Transport prices reflect the cost of movement of goods and people, which is closely linked to petrol prices. According to the National Bureau of Statistics Transport Fare Watch Report, Lagos and Nasarawa States recorded the highest average fares for intra-city bus transportation on fixed routes in October 2025 [5]. The report indicated that Lagos State had the highest average fare of ₦1,405.85 per trip, followed by Nasarawa State with an average fare of ₦1,326.77, while Kwara State recorded ₦1,300.01 per trip [5]. Obviously, transport fares are affected by petrol prices. Similarly, kerosene prices serve as a proxy for household energy costs and are significantly influenced by import dependence and petrol price dynamics. These sector-specific indicators provide a more detailed understanding of sectoral price and inflation pressures within the economy of Nasarawa State. This study adopts a VECM framework examine petrol price transmission and sectoral price movements in Nasarawa State, focusing on key indicators such as the food prices, transport fares, and kerosene prices (National Bureau of Statistics, 2025).

Materials and Methods

Research design

This research uses a quantitative research design based on historical records. The study uses time series data to examine petrol price transmission and sectoral price dynamics in Nasarawa State from the period of 2020 to 2025.

Study population

The population of this study encompasses all available monthly timeseries observations of petrol price and sectoral price data for Nasarawa State, Nigeria of 2020-2025.

Sample size

The sample size comprises of 72 monthly observations, with the data points as monthly sample of information where trends, changes and relationships may be statistically determined.

Data collection

All the data that was used in this research are secondary quantitative data (petrol price data and the sectoral price data) for the period of 2020-2025 provided by the National Bureau of Statistics (NBS) consumer prices record.

Data description

The dataset includes monthly observations of (PMS) petrol price data measured in (₦) per litre, from NBS premium motor spirit (petrol) price watch, food price indicator (FPI) from NBS consumer price index, measured in index point, transport price indicator (TPI) from NBS transport fare watch, measured in (₦) per trip, and kerosene price indicator from NBS national household kerosene price watch measured in (₦) per litre.

Model specification

The study employs the Vector Error Correction Model (VECM) an econometric model suitable to investigate both the short-run and long-run petrol price on sectoral price.

Econometric model

Long-run relationship

The long-run relationship assumes that sectoral price responds systematically to changes in the petrol price. The relationship can be given as:

Food prices

$$\mathrm{FPI_t} = \alpha_1 + \beta_1 \mathrm{PMS}_t + \varepsilon_{1t} \quad (1)$$

Transport prices

$$\mathrm{TPI_t} = \alpha_2 + \beta_2 \mathrm{PMS}_t + \varepsilon_{2t} \quad (2)$$

Kerosene prices

$$\mathrm{KPI_t} = \alpha_3 + \beta_3 \mathrm{PMS}_t + \varepsilon_{3t} \quad (3)$$

Where: $\mathrm{FPI_t}$, $\mathrm{TPI_t}$, $\mathrm{KPI_t}$ = sectoral price indicators at time *t;* $\mathrm{PMS_t}$= petrol price at time *t;* β_i = the long-run effect of petrol price on each sectoral price; α_i= intercept

Short-run dynamics

Given the cointegration among the variables, the **VECM** is used to model short-run adjustments while incorporating long-run equilibrium constraints. This is given as;

Food prices

$$\Delta\mathrm{FPI_t} = \alpha_0 + \sum_{i=1}^{P-1}\gamma_{1i}\Delta\mathrm{FPI}_{t-1} + \sum_{i=1}^{p-1}\delta_{1i}\Delta\mathrm{PMS}_{t-1} + \emptyset_1\mathrm{EC}_{t-1} + u_{1t} \quad (4)$$

Transport prices

$$\Delta\mathrm{TPI_t} = \alpha_0 + \sum_{i=1}^{P-1}\gamma_{2i}i\Delta TPI_{t-1} + \sum_{i=1}^{p-1}\delta_{2i}\Delta\mathrm{PMS}_{t-i} + \emptyset_2\mathrm{EC}_{t-1} + u_{2t} \quad (5)$$

Kerosene prices

$$\Delta\mathrm{KPI_t} = \alpha_0 + \sum_{i=1}^{P-1}\gamma_{3i}i\Delta\,\mathrm{KPI}_{t-1} + \sum_{i=1}^{p-1}\delta_{3i}\Delta\mathrm{PMS}_{t-i} + \emptyset_3\mathrm{EC}_{t-1} + u_{3t} \quad (6)$$

Where: Δ represents first difference operator (captures short-run changes) $\mathrm{ECT_{-1}}$ represents error correction term (lagged deviation from long-run equilibrium), φ_i represents the speed of adjustment toward long-run equilibrium, γ_i represents short-run effects of lagged dependent variables δ_i = short-run effects of lagged petrol price, u_{it} represents white noise error term and p represents optimal lag length, determined by information criteria such as Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC)

Estimation technique: Given the time-series nature of the data (2020–2025), overlooking the non-stationarity of the economic variables may result to spurious analysis and this could negate the tenets of standard econometric techniques. In order to examine the relationship between petrol price and sectoral price variables (food, transport, and kerosene prices), the estimation follows a systematic procedure below:

Unit root test: This study uses both Augmented Dickey–Fuller (ADF), and Phillips–Peron (PP) test to verify the stationarity. For the ADF test, lag length was selected automatically by minimising the Akaike Information Criterion (AIC). A sample size-based rule of thumb. Was used for lag max. ($P_{max} \le \frac{T}{10}$, T=72, hence $P_{max} \le \frac{72}{10}$ =7.2 ≈ 7.). However, because the VECM contains four endogenous variables, a conservative maximum of four lags was specified to limit parameter proliferation and preserve of degree of freedom. Thus, the lag-order was restricted to $p \in \{1,2,3,4\}$. both the level and first-difference tests included an intercept and a linear trend, consistent with equation (7). For the PP test, the long-run variance was estimated using the Newey–West automatic bandwidth selection procedure with a Bartlett kernel, and the same intercept-and-trend specification as the ADF test was retained, consistent with equation (8).

The Augmented Dickey – Fuller (ADF) unit root test is generally given as:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^{p} \delta \Delta Y_{t-i} + \varepsilon_t \qquad (7)$$

Phillips – Peron (PP) unit root test is given as:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \varepsilon_t \qquad (8)$$

Where, Y_t denotes the variables under study, including petrol price, food price, transport price, and kerosene price, ΔY_t indicates the first difference of the series, α = denotes the intercept or constant term, βt represents the time trend component, Y_{t-1}represents the lagged level of the variable, γ represents the coefficient used to test for the presence of a unit root, $\sum_{i=1}^{p} \delta \Delta Y_{t-i}$ represents the lagged differences included to correct for serial correlation, with p, denoting the optimal lag length, and ε_t represents the white noise error term.

The decision rule for both the ADF and PP tests: The null hypothesis of a unit root is rejected if the absolute value of the test statistic exceeds the critical value or if the p-value is less than 0.05. Otherwise, the null hypothesis of non-stationarity is not rejected. Critical values and p-values for both tests follow MacKinnon's (1996) one-sided response-surface approximation, the standard reference distribution reported by R's urca and tseries packages.

The Zivot–Andrews (ZA) unit root test: this test was employed to examine whether each price series is stationary when one structural break is determined endogenously from the data. This is appropriate for the study because the period 2020–2025 contains potentially important price-regime changes. The test was estimated under three specifications which are; a break in the intercept, a break in the trend, and a break in both intercept and trend. The null hypothesis is that the series contains a unit root; rejection of the null indicates that the series is stationary around a structural break. The test was implemented with a 15 % trimming proportion and a maximum lag length of six, with the autoregressive lag selected by the Akaike Information Criterion (AIC). The reported break date is the date associated with the most negative ZA statistic.

Johansen cointegration test: Johansen cointegration was used to examine the existence of a long-run equilibrium relationship between petrol price transmission and sectoral price variables (food prices, transport prices, and kerosene prices) in Nasarawa State over the period 2020–2025. This approach takes care of the endogeneity problems in each model and it gives insight to the number of cointegrating equation(s) and equally evaluates the influence of restrictions on the estimates. The Johansen cointegration test is based on the following VAR given as:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \qquad (9)$$

This can be re-parameterized into a Vector Error Correction form as:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \qquad (10)$$

Where: Y_t = vector of endogenous variables (petrol price, food prices, transport prices, kerosene prices); Δ = denotes the first difference operator; Π = represents the long-run impact matrix; Γ_i= represents the short-run dynamic coefficients; ε_t= represents the error term. The matrix Π is expressed as: $\Pi = \alpha\beta'$ where β represents long-run coefficients and α is measures the speed of adjustment back to equilibrium. In this study the Johansen Approach employs two test statistics to identify the number of cointegration relationships. The tests are trace statistics, that evaluates the null hypothesis at most r cointegrating equations against the alternative of more than $\boldsymbol{r}$, and Maximum statistic, that tests the null hypothesis of $\boldsymbol{r}$ cointegrating equations against $\boldsymbol{r} + \mathbf{1}$.

Trace statistic

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i), \qquad (11)$$

Decision rule

Reject H_0 if $\lambda_{trace}(r) > CV_{trace}(r, \alpha)$, Otherwise, do not reject the null hypothesis.

Max-eigen statistic

$$\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1}), \qquad (12)$$

Decision rule

Reject H_0 if $\lambda_{max}(r, r+1) > CV_{max}(r, \alpha)$, Otherwise, do not reject the null hypothesis.

Where: T = Number of observations; λ = Eigenvalues; r = Number of cointegrating vectors.

Vector error correction model (VECM): It was employed in this study to estimate both the short-run dynamics and long-run equilibrium relationship between petrol price transmission and sectoral price variables such as, food prices, transport prices, and kerosene prices in Nasarawa State, Nigeria. The VECM specification is given as:

$$\Delta Y_t = \alpha + \Pi Y_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \qquad (13)$$

Where: ΔY_t represents the Vector of first-differenced endogenous variables (petrol price, food prices, transport prices, kerosene prices); α represents Constant term; ΠY_{t-1}represents Error correction term capturing the long-run equilibrium relationship; Γ_i represents Short-run dynamic coefficients; and ε_t represents the error term.

Diagnostic tests: was used in order to ensure the reliability and validity of the estimated Vector Error Correction Model (VECM). These tests are utilized in order to confirm that the model satisfies key econometric assumptions and that the results are suitable for inference. The diagnostic tests carried out are namely; the test for serial correlation using the

Portmanteau Test, the test for heteroskedasticity using the ARCH LM Test, and the test for normality of residuals using the Jarque–Bera Test. furthermore, the stability of the model is examined using the CUSUM Test. Also, the decision rule for all tests is based on a 5 % significance level and a p-value greater than 0.05 indicates that the null hypothesis (H_0) cannot be rejected, which implies that the model gratifies the important econometric assumptions. Therefore, the diagnostic tests ensures that the estimated VECM for petrol prices and sectoral prices (food, transport, and kerosene) is statistically reliable and suitable for interpretation and policy analysis.

Results and Discussion

The trend of petrol prices and sectoral prices in Nasarawa State from 2020 to 2025

Table 1 summarizes the descriptive statistics of the variables over the study period. these provides an overview of the movement of the variables before proceeding to the subsequent time-series analysis.

Table 1 presents descriptive statistics of food prices (FPI), transport prices (TPI), kerosene prices (KPI), and petrol price. The table is based on 72 monthly observations covering the study period. The result amongst others, displays the mean of FPI, TPI, KPI, PMS as (507.626), (1,817.742), (1,042.437), (490.544) respectively. Also, the standard deviation measured how much the variables changed over time. Therefore, FPI, TPI, KPI, PMS, has a standard deviation of (251.022), (827.171) (678.636), (395.397), respectively.

Table 1: Descriptive statistics

Variable	Mean	Std. Dev.	Median	Min	Max	Skew	Kurtosis
FPI	507.626	251.022	475.005	105.500	1,074.300	0.242	-0.522
TPI	1,817.742	827.171	1,548.517	665.666	3,361.431	0.236	-1.520
KPI	1,042.437	678.636	925.375	322.420	2,814.230	0.709	-0.426
PMS	490.544	395.397	222.150	128.880	1,261.650	0.688	-1.124

N=72(number of observations)

Source: Analysis by researcher using R Software, 2026

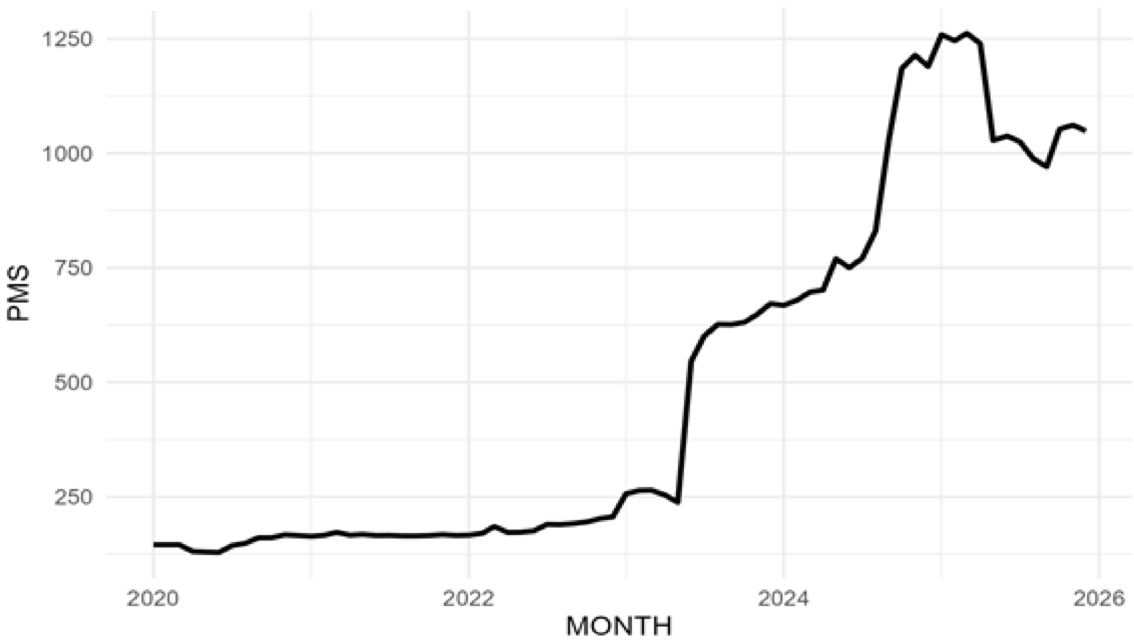

Figure 1: Trend of petrol prices in Nasarawa State, Nigeria (2020–2025)

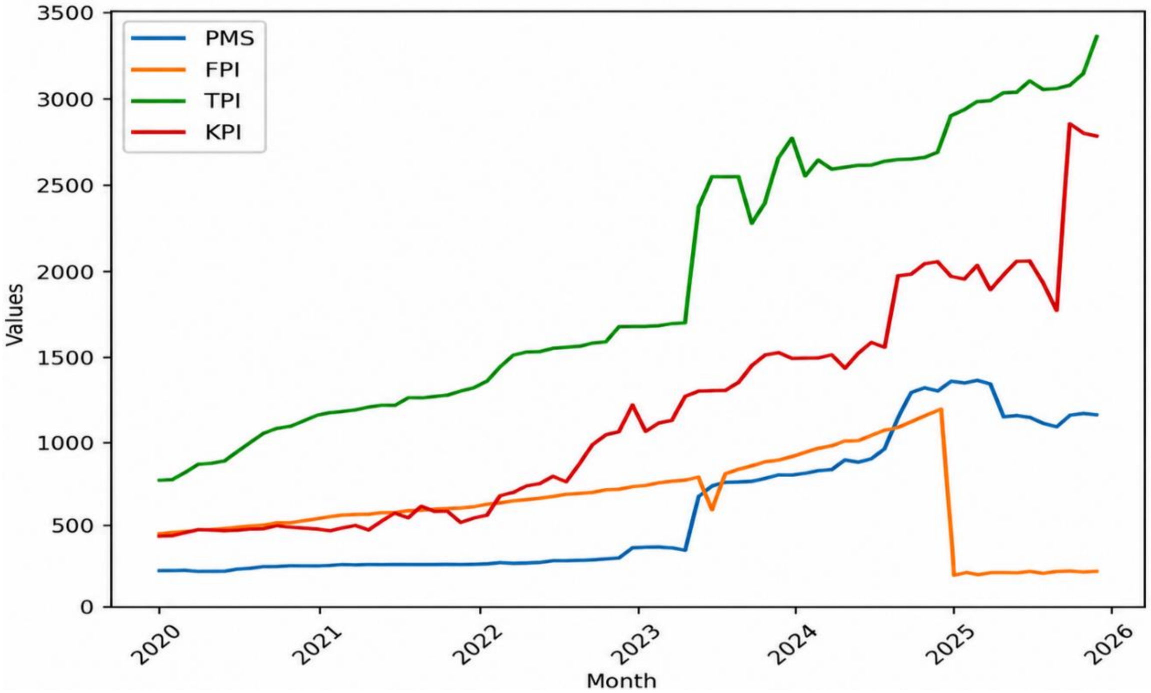

Figure 2: Trend graph of PMS and sectoral prices in Nasarawa State

Overall, the descriptive statistics indicates variations in the behavior of FPI, TPI, KPI, and PMS over the study period, preliminary evidence of movements that guarantees further investigation.

Figure 1 presents the monthly trends in PMS prices to provide a visual of the movement and changes over the study period.

The Trend graph exposes that petrol prices was relatively stable between 2020 and early 2022, with only minor fluctuations but from 2023 onward, there was a sharp increase of petrol prices, which indicates significant fuel price adjustments during the period. From this graph, the persistent rise can likely link to fuel subsidy removal, and deregulation policies within the Nigerian petroleum sector which invariably has its effect in sub-national level of Nasarawa State. Although there was an existence of slight declines toward the later part of the study period, petrol prices generally maintained an upward trend and it may have significant effects for sectoral price dynamics in Nasarawa State, most especially in transportation, food, and kerosene.

Figure 2 presents the monthly trends of PMS, FPI, TPI, and KPI. This gives the visuals of the fluctuations in these variables over the study period

Figure 2 revealed that PMS and sectoral price indicators generally exhibit upward movements over the study period, although with varying degrees of volatility. TPI records the most pronounced and sustained increase, followed by KPI and FPI. PMS remains relatively stable initially but rises sharply from 2023 onwards. The observed co-movements suggest possible linkages between petrol prices and sectoral prices. However, the existence of short-run and long-run relationship is established through the subsequent econometric analysis.

Long-run relationship between petrol prices and selected sectoral price indicators in Nasarawa State from 2020 to 2025

Unit root test

Augmented Dickey-Fuller (ADF) Unit Root Test and Phillips-Perron (PP) Unit Root Test were employed to examine whether the variables have unit root. The tests were performed at both levels and first difference. And Zivot–Andrews Test was also employed specifically for structural-break unit root test.

Table 2 present the Augmented Dickey-Fuller (ADF) Unit Root Test at Level, to determine whether the variables are stationary. Table 2 shows that food prices, transport prices, kerosene prices and petrol prices are non-stationary at l(0) because their p-values > 0.05, hence we accept the H_0 that all variables have unit root and are non- stationary at levels.

Table 2: Augmented Dickey-Fuller (ADF) unit root test at level

Variable	ADF T-Stat	Prob. Values	Integ. Order	Remark
FPI	-1.5795	0.8042	I(0)	Non-Stationary
TPI	-3.0229	0.6058	I(0)	Non-Stationary
KPI	-2.1295	0.7701	I(0)	Non-Stationary
PMS	-2.0568	0.5261	I(0)	Non-Stationary

Source: Analysis by researcher using R Software, 2026

Table 3: Augmented Dickey-Fuller (ADF) Unit Root Test at First Difference

Variable	ADF T-Stat	Prob. Values	Integ. Order	Remark
FPI	-6.1265	0.0187	I(1)	Stationary
TPI	-6.4680	0.0100	I(1)	Stationary
KPI	-7.8668	0.0800	I(1)	Non-Stationary
PMS	-5.1332	0.1686	I(1)	Non-Stationary

Source: Analysis by researcher using R Software, 2026

Table 3 presents the Augmented Dickey-Fuller (ADF) Unit Root Test at First Difference to determine the whether the variables are stationary. Table 3 shows that only FPI and TPI are stationary at l(1) because their p-values < 0.05 while KPI and PMS are not. This could be as a result of the possibility of structural changes in petroleum prices during 2023 fuel subsidy removal in Nigeria or other short-run disturbances in the monthly price data. In particular KPI and PMS did not reject the null hypothesis of a unit root at l(1) under the ADF specification. Given that unit root test may differ in their sensitivity to serial correlation, deterministic components, and the finite-sample properties of the data, reliance on a single test led to an inconclusive determination of the order of integration. Consequently, the Phillips-Perron (PP) unit root test was employed as a robustness check.

Table 4 presents the Phillips-Perron (PP) Unit Root Test at Level to determine the whether the variables are stationary. Table 4 shows that all prices are non-stationary as their p-value > 0.05 at l(0). Hence, we accept the H_0 that all variables have unit root and are non- stationary at levels.

Table 4: Phillips-Perron (PP) unit root test at level

Variable	PP T-Stat	Prob. Values	Integ. Order	Remark
FPI	-6.9931	0.7043	I(0)	Non-Stationary
TPI	-13.87	0.2929	I(0)	Non-Stationary
KPI	-14.406	0.2608	I(0)	Non-Stationary
PMS	-6.371	0.7415	I(0)	Non-Stationary

Source: Analysis by researcher using R Software, 2026

Table 5: Phillips-Perron (PP) unit root test at first difference

Variable	PP T-Stat	Prob. Values	Integ. Order	Remark
FPI	-73.4302	<0.01	I(1)	Stationary
TPI	-55.5278	<0.01	I(1)	Stationary
KPI	-77.0149	<0.01	I(1)	Stationary
PMS	-55.0188	<0.01	I(1)	Stationary

Source: Analysis by researcher using R Software, 2026

Table 5 presents Phillips-Perron (PP) Unit Root Test at First Difference to determine the whether the variables are stationary. Table 5 shows that all variables are stationary at l(1), since their p-value is (< 0.01). The PP test provides the complementary evidence that the variables share a common order of integration. This is particularly important for the subsequent cointegration analysis because VECM require all variable to be l(1).

Table 6 presents the Zivot–Andrews Unit Root Test. This was employed examine the stationarity properties of the variables while allowing for an endogenous structural break. This test is important because the study period includes the 2023 petrol subsidy removal that may have caused a structural change in the behavior of petrol prices. The results are presented in Table 6.

Table 6: Zivot–Andrews (ZA) unit root test

Variable	Level ZA	p-value	Level Break	1st Diff. ZA	p-value	Integ. Order
FPI	-13.6478	0.0008	Dec-2024	-12.6704	0.0008	I(0)
TPI	-9.9550	0.0009	May-2023	-6.8272	0.0010	I(0)
KPI	-4.6050	0.1696	Nov-2021	-9.3061	0.0009	I(1)
PMS	-3.3229	0.8857	May-2023	-7.5622	0.0010	I(1)

The 5 % critical value for the intercept-and-trend specification is −5.0733. A ZA statistic more negative than this value leads to rejection of the unit-root null at the 5 % level.

Table 6 reports the principal results under the intercept-and-trend specification, which is the main specification emphasized for price series that may exhibit deterministic trend and a one-time regime shift. This is to account for the possibility of structural changes in the price series.

FPI: Food Prices (FPI) are stationary at level under the intercept-and-trend specification. The ZA statistic is −13.6478, which is substantially more negative than the 5 % critical value of −5.0733 (p = 0.0008). The estimated break occurs in December 2024. Therefore, the unit-root null is rejected at the 5 % level, indicating that FPI is I(0) when a structural break is allowed.

TPI: Transport Prices (TPI) are also stationary at level under the intercept-and-trend specification. The ZA statistic of −9.9550 is more negative than −5.0733 (p = 0.0009), with an estimated break in May 2023. Hence, the unit-root null is rejected at the 5 % level and TPI is classified as I(0) under the ZA test.

KPI: Kerosene Prices (KPI) are not stationary at level under the intercept-and-trend specification. The level ZA statisticthis is −4.6050, which is less negative than the 5% critical value of −5.0733 (p = 0.1696). The estimated level break is November 2021. However, after first differencing, KPI becomes stationary: the ZA statistic is −9.3061 (p = 0.0009), with the break estimated at December 2024. Thus, KPI is I(1) under the main specification.

PMS: Petrol Prices (PMS) are not stationary at level under the intercept-and-trend specification. The ZA statistic is −3.3229 (p = 0.8857), and does not exceed the 5% rejection threshold. The estimated level break is May 2023. After first differencing, the series becomes stationary, with a ZA statistic of −7.5622 (p = 0.0010) and an estimated break in January 2025. PMS is therefore I(1). Thus the Zivot- Andrews test provides evidence of heterogeneous integration properties when structural breaks are explicitly considered, with FPI and TPI classified as l(0), while KPI and PMS are l(1).

Results across the three ZA specifications
The three specifications provide an important robustness check. At the 5 % level, FPI and TPI reject the unit-root null under both the intercept-only and intercept-plus-trend specifications, while their trend-only statistics do not reach the 5% rejection threshold. KPI rejects the unit-root null only under the trend-break specification at level, and PMS does not reject the null at level under any of the three specifications. All four variables become stationary after first differencing across the specifications. Table 7 presents the complete set of ZA statistics.

Table 7: ZA statistics and decisions

Variable	Order	Break Model	ZA Statistic	p-value	Lag	Break Date
FPI	Level	Intercept (Level shift)	-15.9335	0.0000	0	Dec-2024
FPI	Level	Trend (Trend shift)	-4.1419	0.0989	0	Aug-2024
FPI	Level	Intercept + Trend	-13.6478	0.0008	0	Dec-2024
FPI	First Difference	Intercept (Level shift)	-9.6929	0.0000	0	Dec-2024
FPI	First Difference	Trend (Trend shift)	-8.9417	0.0021	0	Oct-2023
FPI	First Difference	Intercept + Trend	-12.6704	0.0008	0	Dec-2024
TPI	Level	Intercept (Level shift)	-9.1778	0.0000	1	May-2023
TPI	Level	Trend (Trend shift)	-3.7975	0.2064	1	Feb-2022
TPI	Level	Intercept + Trend	-9.9550	0.0009	1	May-2023
TPI	First Difference	Intercept (Level shift)	-6.6997	0.0001	3	Jan-2024
TPI	First Difference	Trend (Trend shift)	-6.0292	0.0034	3	Jul-2023
TPI	First Difference	Intercept + Trend	-6.8272	0.0010	3	May-2023
KPI	Level	Intercept (Level shift)	-3.8204	0.4656	0	Aug-2024
KPI	Level	Trend (Trend shift)	-4.6259	0.0280	0	Feb-2022
KPI	Level	Intercept + Trend	-4.6050	0.1696	0	Nov-2021
KPI	First Difference	Intercept (Level shift)	-8.0157	0.0000	1	Jan-2023
KPI	First Difference	Trend (Trend shift)	-8.2813	0.0023	1	Feb-2025
KPI	First Difference	Intercept + Trend	-9.3061	0.0009	1	Dec-2024
PMS	Level	Intercept (Level shift)	-3.9259	0.3969	1	May-2023
PMS	Level	Trend (Trend shift)	-2.4934	0.9008	1	Feb-2022
PMS	Level	Intercept + Trend	-3.3229	0.8857	1	May-2023
PMS	First Difference	Intercept (Level shift)	-7.5688	0.0000	0	Jan-2025
PMS	First Difference	Trend (Trend shift)	-7.1350	0.0027	0	Oct-2024
PMS	First Difference	Intercept + Trend	-7.5622	0.0010	0	Jan-2025

The difference between the Zivot–Andrews results and the conventional unit-root tests suggests that structural breaks may influence the stationarity classification of the series within the study period. Therefore, the results were interpreted jointly rather than relying on a single unit-root test. In particular, the PP test provided evidence that all four variables are I(1), while the ADF test provided evidence of first-difference stationarity for FPI and TPI. The Zivot–Andrews results further demonstrated that structural breaks are relevant to the behaviour of the series. The combined evidence was subsequently used to assess the suitability of the Johansen cointegration procedure.

Lag length selection criteria
Table 8 presents the Lag Length Selection Criteria. The optimal lag length was determined using Akaike information criterion (AIC), Hannan-Quinn information criterion (HQ), Schwarz information criterion (SIC) and Final prediction error criterion (FPE). The results of the lag-order is presented in the following Table 8. The Table displays all the selection criteria such as AIC, HQ, SC, FPE in which selected lag one (1) as the optimal lag length, and it confirmed the minimum information criterion values compared to other lag lengths. This signifies that a lag length of one is the most appropriate for capturing the dynamic relationship among petrol price and sectoral price in Nasarawa State.

Table 8: Lag length selection criteria

AIC(n)	HQ(n)	SC(n)	FPE(n)
36.8533*	37.1119*	37.5061*	10.130E+21*
36.9626	37.4282	38.1376	11.359E+21
36.9841	37.6566	38.6814	11.756E+21
37.0360	37.9154	39.2555	12.686E+21

Source: Analysis by researcher using R Software, 2026

Table 9: Johansen trace cointegration test

Hypothesis	Trace Statistic	Critical Value (5 %)	Decision
r <= 3	6.9748	9.24	No Cointegration
r <= 2	19.067	19.96	No Cointegration
r <= 1	41.5673	34.91	Cointegration Exists
r = 0	69.6121	53.12	Cointegration Exists

Source: Analysis by researcher using R Software, 2026

Table 9 presents the Johansen Trace Cointegration Test to determine whether a long-run equilibrium relationship exist among the variables in the model. Table 9 reveals the trace statistics which identified r <= 2 and r <= 3, and it is lower than their corresponding critical value, leading to the acceptance of the null hypothesis at those levels whereas in r <= 1 and r = 0, the null hypothesis of no cointegration was rejected because it is greater than their respective critical value. Therefore, The presence of two cointegrating relations indicates long-run co-movement among PMS, FPI, TPI, and KPI over the study period, consistent with a shared long-run equilibrium linking petrol price to sectoral prices in Nasarawa State.

The short-run adjustment dynamics between PMS prices and sectoral price using the Vector Error Correction Model (VECM) from 2020 to 2025

Following the confirmation of cointegration among the variables, Table 10 presents the Vector Error Correction Model (VECM).

Table 10: Vector Error Correction Model (VECM)

Equation	Variable	Coefficient	S.E	t-Statistics	P-value	Decision
FPI Equation	FPI	-0.2978	0.1183	-2.5177	0.0143	Significant negative effect
	TPI	-0.1703	0.1447	-1.1771	0.2435	Insignificant negative effect
	KPI	-0.1166	0.0877	-1.3302	0.1882	Insignificant negative effect
	PMS	0.6171	0.2983	2.0691	0.0426	Significant positive effect
TPI Equation	FPI	0.1066	0.1196	0.8909	0.3763	Insignificant positive effect
	TPI	0.0101	0.1464	0.0692	0.9450	Insignificant positive effect
	KPI	0.1630	0.0887	1.8373	0.0708	Insignificant positive effect
	PMS	-0.0372	0.3017	-0.1231	0.9024	Insignificant negative effect
KPI Equation	FPI	-0.0026	0.1798	-0.0146	0.9884	Insignificant negative effect
	TPI	-0.0433	0.2199	-0.1967	0.8447	Insignificant negative effect
	KPI	-0.2370	0.1333	-1.7781	0.0801	Insignificant negative effect
	PMS	0.3967	0.4535	0.8748	0.3849	Insignificant positive effect

Source: Analysis by researcher using R Software, 2026

Table 10 revealed that in the Food prices (FPI) equation, the changes in petrol price exerted a positive and significant transmission on food prices, with a coefficient value of 0.6171 and a t-statistic of 2.0691 and probability value of 0.0426. Also, FPI displayed a significant negative effect on itself with -0.2978 and -0.0143 as coefficient value and probability value respectively, which indicates a short-run adjustment and this implies that increases in petrol prices significantly add to rising food prices in Nigeria in the short run. Meanwhile, the Transport prices (TPI) equation, petrol price changes showed a negative but insignificant effect on transport prices, which shows weak short-run transmission. Similarly, in the KPI equation, the variation in petrol price conserved a positive insignificant relationship with KPI, and this suggests limited short-run transmission.

Table 11 presents the Diagnostic Test, which includes the Portmanteau Q(2), the Portmanteau Q(12) and Multivariate normality, to determine the adequacy reliability of the estimated VECM.

Table 12 presents the equation-level residual checks for each equation of the VECM, comprising the Q(1) test for first-order autocorrelation and the ARCH LM(1) test for heteroskedasticity.

Table 11: Diagnostic test

Test	Statistic	p-value	Decision
Portmanteau Q(2)	22.581	0.0039	Reject H0
Portmanteau Q(12)	226.667	0.0017	Reject H0
Multivariate normality	5597.966	<0.0001	Reject H0

Table 12: Equation-level checks

Equation	Q(1)	Q(1) p-value	ARCH LM(1)	ARCH p-value
FPI	1.130	0.2877	1.004	0.9897
TPI	0.012	0.9127	0.029	0.0281
KPI	0.116	0.7336	0.313	0.3053
PMS	0.000	0.9969	0.036	0.0351

Sources: Analysis by researcher using R Software, 2026

From Table 11 and Table 12, The lag-1 VECM is not fully satisfactory on residual diagnostics. The equation-level Q(1) tests do not show significant first-order autocorrelation, and ARCH LM(1) is insignificant for FPI, TPI, KPI and PMS. However, the multivariate Portmanteau tests reject the null of no residual autocorrelation at Q(2) and Q(12), while the multivariate normality test is strongly rejected. However, a robust check is made below for further clarity of the model. In addition to the diagnostic tests in Tables 11 and 12, this check re-estimates the model and examines Ljung–Box residual autocorrelation, ARCH LM(1), Jarque–Bera/Shapiro normality, and robust residual outliers using median/MAD z-scores. A robust z-score above 3.5 in absolute value is flagged.

Table 14 presents the multivariate diagnostic results of the re-estimated model, namely the multivariate Portmanteau tests at lags 2 and 12 and the multivariate normality test. From Table 13 & Table 14, Q(2)=23.207 (p=0.003109) and Q(12) = 251.852 (p=2.984e-05) reject no-autocorrelation. The multivariate normality statistic is 5597.966 (p < 0.001), so normality is strongly rejected. These findings are consistent with the conclusion of the diagnostic tests in Tables 11 & 12 that lag 1 is not fully satisfactory on residual diagnostics.

Table 13: Robust diagnostic check

Equation	LB Q(1) statistic	LB Q(1) p-value	LB Q(12) statistic	LB Q(12) p-value	ARCH LM(1) statistic	ARCH p-value	Jarque-Bera statistic	JB p-value	Shapiro p-value	Robust outliers |z|>3.5
FPI	1.13	0.2877	6.598	0.883	1.004	0.3162	2227	0	7.06e-12	2
TPI	0.01203	0.9127	13.74	0.3176	0.02888	0.865	936.3	4.945e-204	2.649e-10	4
KPI	0.1158	0.7336	2.53	0.998	0.313	0.5758	2171	0	1.967e-12	3
PMS	1.53e-05	0.9969	10.71	0.5535	0.03612	0.8493	604.6	5.157e-132	2.948e-11	7

Table 14: Multivariate diagnostic results

Test	Statistic	p-value	Decision
Multivariate Portmanteau Q(2)	23.2066	0.00310891	Reject H0
Multivariate Portmanteau Q(12)	251.852	2.98404e-05	Reject H0
Multivariate normality	5597.97	0	Reject H0

Table 15: Structural break analysis

Series	Break index	Estimated break month	Chow F	Chow p-value	Decision
FPI	23	2021-12	6.75386	0.00211129	Significant
FPI	42	2023-07	34.529	4.47254e-11	Significant
FPI	60	2025-01	605.887	4.60017e-44	Significant
TPI	41	2023-06	143.561	3.91242e-25	Significant
TPI	60	2025-01	1.05029	0.355442	Not significant
KPI	26	2022-03	38.8483	5.5978e-12	Significant
KPI	60	2025-01	10.9584	7.49404e-05	Significant
PMS	41	2023-06	80.9893	1.01844e-18	Significant
PMS	57	2024-10	33.9248	6.04386e-11	Significant

Structural break analysis

Estimated breaks were identified from the raw level series using a piecewise-linear segmentation criterion with AIC selection (up to four breaks and a minimum 12-month segment). Estimated dates were then checked with a Chow test for a break in intercept and trend. These are diagnostic break indicators rather than a claim that a particular economic event caused the break. Table 15 presents the estimated break dates and the corresponding Chow test results.

The strongest recurring break window is around June–July 2023, appearing in TPI and PMS and adjacent to the FPI Estimated break. January 2025 is also a major Estimated for FPI and KPI. Other series-specific breaks occur around December 2021 (FPI), March 2022 (KPI), and October 2024 (PMS).

Overall, despite the evidence of residual serial correlation, the VECM is retained as the principal modelling framework because its fundamental requirements are satisfied by the times series properties of the data. Also, the Johansen cointegration test establishes the existence of long-run equilibrium relationships among the variables. However, the residual diagnostic finding is therefore treated as a limitation of the selected specification rather than as evidence against the existence of the underlying long-run relationships. The robustness assessment indicates that increasing the lag length does not provide sufficient claim for abandoning the criterion selected specification, while the structural break analysis indicates the presence of changes in the movement of the series that may contribute to residual dependence. Consequently, the VECM is retained because it remains the econometrically appropriate framework for examining both the long-run equilibrium relationship and short-run adjustment dynamics of FPI, TPI, KPI and PMS.

The speed of adjustment toward long-run equilibrium using the Error Correction Mechanism from 2020 to 2025

Table 16 presents the Error Correction Term (ECT). The ECT determines the speed at which the variables (FPI, TPI, KPI and PMS) adjust towards their long-run equilibrium following a short-run deviation.

Table 16 shows the Error Correction Term (ECT) coefficients for both cointegrating relations in each equation, and the pattern is more mixed than a single adjustment speed per equation. In the FPI equation, ect_1 (–0.2186, p = 0.0004) is negative and statistically significant, consistent with FPI correcting about 21.9% of a deviation from this long-run relation each period; however, ect_2 in the same equation (0.2329, p = 0.0001) is positive and statistically significant, which is the wrong sign for stable error correction and indicates that FPI moves away from, rather than back toward, that particular long-run relation. In the TPI equation the pattern is reversed: ect_1 (0.0169, p = 0.7759) is statistically insignificant, while ect_2 (–0.2181, p = 0.0003) is negative and significant, indicating that TPI corrects about 21.8% of a deviation from the second cointegrating relation each period. In the KPI equation, neither ect_1 (–0.1427, p = 0.1134) nor ect_2 (0.0701, p = 0.4109) is statistically significant, so no evidence of active error correction toward either long-run relation is found for kerosene prices. The adjustment behaviour is summarized in Table 17.

Table 16: Error correction term (ECT)

Equation	Error Correction Term	Coefficient	S.E	t-Statistics	P-value	Decision
FPI Equation	ect_1	-0.2186	0.0585	-3.7381	0.0004	(-) and significant at 21.86% adjustment
	ect_2	0.2329	0.0557	4.1804	0.0001	(+) and diverges
TPI Equation	ect_1	0.0169	0.0592	0.2859	0.7759	(+)and Insignificant
	ect_2	-0.2181	0.0564	-3.8701	0.0003	(-) and significant at 21.81% adjustment
KPI Equation	ect_1	-0.1427	0.0889	1.6049	0.1134	(-) but insignificant indicates 14.27% weak adjustment
	ect_2	0.0701	0.0847	0.8277	0.4109	(+)and insignificant

Source: Author's computation results using R Software (2026)

Table 17: Summary of error correction term adjustment behaviour

Equation	ECT	Coefficient	S.E.	t-stat	P-value	Interpretation
FPI	ect1	-0.2186	0.0585	-3.7381	0.0004	Significant, correctly signed – stabilizing (~21.9%/period)
FPI	ect2	0.2329	0.0557	4.1804	0.0001	Significant, wrong sign – destabilizing
TPI	ect1	0.0169	0.0592	0.2859	0.7759	Not significant
TPI	ect2	-0.2181	0.0564	-3.8701	0.0003	Significant, correctly signed – stabilizing (~21.8%/period)
KPI	ect1	-0.1427	0.0889	1.6049	0.1134	Not significant
KPI	ect2	0.0701	0.0847	0.8277	0.4109	Not significant

FPI's ect_2 carries a significant but wrong-signed coefficient, and neither of KPI's adjustment coefficients is significant. This means the claim of a uniformly "stable long-run relationship" and gradual convergence to equilibrium across all four series is not fully supported by these results; adjustment toward long-run equilibrium is confirmed only for FPI and TPI, while KPI shows no significant short-run adjustment and FPI's response to the second relation is destabilising rather than corrective. So, the FPI and TPI adjustment coefficients are best read as evidence of partial, equation-specific error correction within the estimated four-variable VECM system, rather than as adjustment toward a fully identified structural long-run relationship.

Discussion of Findings

This study has statistically examined the monthly time series data sourced in determining the petrol price transmission and sectoral price dynamics in Nasarawa State, Nigeria 2020 to 2025 using Vector Error Correction Model (VECM). With respect to the relationship between petrol price and sectoral price in Nasarawa State, the Johansen test established two cointegrating relations, indicating long-run co-movement among PMS, FPI, TPI, and KPI over 2020–2025. The short-run VECM and ECT results reported above provide more selective support for a transmission mechanism: petrol price changes have a significant short-run effect on food prices (Table 10) and FPI and TPI each show significant, correctly-signed error correction toward one of the two long-run relations, whereas KPI shows no significant short-run effect from petrol price and no significant error correction in either equation. Together these results are consistent with a transmission mechanism from petrol price to food and, more tentatively, transport prices, but they do not establish a uniform transmission mechanism to all three sectoral prices, and cointegration establishes co-movement rather than the direction of causality; formal causal-direction testing (e.g. Granger causality or impulse response analysis) was outside the scope of this study and is noted as an area for future extension. This finding supports the study of Bobai 2012 [6], who analysed the relationship between petroleum prices and inflation in Nigeria. And found that PMS exert higher effect on prices of items in Nigeria.

The findings showed two cointegration equation of long-run equilibrium relationship among PMS, FPI, TPI, and KPI. This implies that although the variables may experience short-run deviation, they share a common long-run relationship over the study period. The significant error-correction terms further shows that deviations from the long-run equilibrium are corrected gradually overtime, with the key equations; FPI (ECT1= -0.2186, P=0.0004), TPI (ECT2= -0.2181, P=0.003), exhibiting an adjustment speed of approximately 22 %. This adjustment behaviour is not uniform across the system, however: FPI's second error-correction coefficient (ect2 = 0.2329, p = 0.0001) is significant but positively signed, indicating divergence from that particular long-run relation rather than correction toward it, and neither of KPI's error-correction coefficients is statistically significant, so no active adjustment toward long-run equilibrium is confirmed for kerosene prices. Therefore, PMS price changes are associated with the long-run dynamics of sectoral prices in Nasarawa State, most clearly for food and transport prices. While the short-run VECM results showed that PMS price changes are transmitted most clearly to food prices, while transmission to transport and kerosene prices may be limited. Also, regarding the food price, the findings support through the VECM that there is a positive transmission of petrol price. Interestingly, in Nasarawa State food cost or agricultural products responds to petrol price volatility, which presently, both households and public firms are been affected. This finding agrees with the cost-push inflation theory as an increase in the cost of production inputs, such as petrol leads to an increase in prices. Consequently, higher petrol prices increase the cost of moving food items from rural production centers to urban markets, thereby exerting upward pressure on food prices but Kerosene prices only experienced weak transmission relationship possibly due to differing market structures consumption patterns, availability of alternative energy sources and subsidy regimes.

The findings of this study have shown that the transport sector experienced some transmission effect from the changes in petrol prices in Nasarawa State. These findings are consistent with previous studies which showed that fuel subsidy removal and rising petrol prices significantly increased transportation costs in Nigeria [7]. These transmission effect could be attributed to the official removal of petrol subsidy by the Federal Government of Nigeria, in the month of May, 2023 which has not been formally reintroduced [8]. While kerosene showed a weak transmission effect. This could be attributed to differences in the pricing, demand and market conditions of the two petroleum products. Also, evidence from NBS 2022 data showed that Nasarawa State recorded the lowest average kerosene price per litre among the states in June 2022 at ₦618.06 with relatively low prices in subsequent periods [9].

In addition, the food sector recorded a transmission effect which agrees with the findings of Omang *et al.* [10], who found a significant long-run relationship between fuel subsidy removal and food inflation, this is primarily because food and agricultural items are moved from place to place, so increase in transportation cost as a result of petrol price changes leads to increase in production cost. The existence of the response across several periods further suggests that petroleum price shocks have lasting effects on food prices, reflecting structural dependence on fuel-driven transportation and weak cost-absorbing mechanisms within the economy.

In conclusion, the study was able to detect the evidence of transmission among petrol prices and sectoral price dynamics within Nasarawa State particularly through transportation and food distribution channels, and this may also be source of pressures of rise in prices of items across sectors.

Conclusion and Recommendations

This study examined statistically with the use of Vector Error Correction Model (VECM), the petrol price transmission and sectoral price dynamics in Nasarawa State, Nigeria (2020-2025), using Food prices (FPI), Transport prices (TPI), and Kerosene prices (KPI) as indicators of sectoral price. In order to establish the aim of the study, the study made use of monthly secondary data from January 2020 to December 2025 and also analyzed the data statistically using descriptive statistics, Unit root test, Vector Error Correction Model (VECM), and diagnostic test. From the study, the findings revealed that there is existence of transmission of petrol prices to sectoral price, most especially in food prices and transport prices, whereas the transmission to Kerosene prices appeared to be weak, and this may be due to structural and market related factors within Nasarawa State, Nigeria petroleum such as demand patterns, supply mechanisms, and consumption behavior sector.

Based on the results of the study, the following recommendations are made:

1. Government should also inspire private sector to involve in refining crude oil so as to promote competition which shall help to reduce petrol prices.
2. Instead of government fixing petrol prices arbitrary, price determination should rely on market mechanism to ensure efficiency and transparency.
3. The operations of independent companies and their salespersons should be well regulated and engage supervision to ensure fair trading management.

Conflict of interest: The author declares no conflict of interest regarding this study.

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