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Distributive Lag Effects of Inflation Dynamics on Petroleum Pump Price in Nigeria: Implications for Formalized Informalities?

by

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Abstract:

This study estimated the distributive lag effects of inflation dynamics on petroleum pump price in Nigeria, from 1986 to 2023 using as consumer price index (CPI), producer price index (PPI) and food price index, (FPI) as independent variables the indicators of inflation dynamics and petroleum pump price as a dependent variable. By sourced data from Central Bank of Nigeria and utilized Augmented Dickey-Fuller (ADF), correlation matrix, optimal lag length determination, ARDL bound test of cointegration, and Granger causality as methods of data analysis. Based on the analysis, the result revealed that the coefficient values of CPI, PPI and FPI are 0.021150, 0.051849, and 0.460294 respectively, but none being statistically significant at conventional levels (p-values > 0.05) and the R-squared value is 0.78117, while the adjusted R-squared values of 0.678632. There is a significant short-term effect of inflation dynamics on petroleum pump price, but significant long-term effect failed to exist. There is a unidirectional causality from PPP to PPI as revealed by the Granger causality test result. Based on this, it is concluded that inflation dynamics only have distributive lag effects on petroleum pump price in the short run, but not in the long-term. It is therefore recommended, among others, that interventions aimed at controlling food petroleum pump price by the government should focus on regulating the activities of the informal sector in the oil and gas sub-industry in order address the issue of formalized informalities.

Keyword: Distributive Effects, Inflation, Petroleum, Price, ARDL, Formalized Informality.
JEL Classification: E26, E31, O11, O13, P44, Q41.

1. Introduction

Monetary authorities, governments, and policymakers around the world continue to be very concerned about the trends, causes, and behaviors of inflation over time, including how prices fluctuate in response to different economic factors like supply and demand, monetary policy, and external shocks. Inflation dynamics has focused on how inflation develops and what factors affect its movement within an economy. The International Monetary Fund (IMF) report from 2024 sheds light on the course of the dynamics of global inflation, which have seen notable ups and downs in recent years. The COVID-19 pandemic, supply chain interruptions, geopolitical events, and policy reactions are some of the variables that have combined to effect this. Low inflation was brought on by the pandemic in 2020 when lockdowns and economic uncertainty reduced consumer demand.

However, due to labor shortages and supply chain disruptions, demand recovered more quickly than supply as economies reopened. By the third quarter of 2022, the median value of worldwide inflation rate had risen to 8.7% due to this mismatch (Greenidge & Dacosta, 2019). Within African economies, a complex interaction of factors, including supply and demand shocks, monetary and fiscal policies, exchange rate changes, and foreign influences, affects the dynamics of inflation (such as the consumer price index, producer pricing index, and food price index). Achieving economic stability and progress throughout the continent requires a comprehensive contextualization of these dynamics.

A number of intricately interacting elements, such as monetary policies, currency rate swings, fiscal dynamics, and structural problems, have contributed to Nigeria's ongoing inflationary problem. Nigeria had significant rates of inflation in the 1980s and 1990s, frequently surpassing 30% (National Bureau of Statistics, NBS, 2020). This trajectory was caused by a number of factors, including fiscal deficits, foreign shocks, and excessive money supply increase (Qayyum, 2016).

In 2000s, inflation rates moderated between 5% and 15%; an outcome attributed to improved monetary policy frameworks and relative political stability (Ratnasiri, 2019; Sani, Ismaila & Adamu 2016). A decade later, it became volatile, influenced by factors like global oil price fluctuations, exchange rate pressures, and insurgencies affecting agricultural production. From 2022 to 2022, inflation dynamics accelerated, peaking at 21.47% in November 2022. This was reportedly driven by factors such as food supply disruptions, exchange rate depreciation, and rising production costs (Chaudhary & Ahmad, 2016). Inflation continued to rise, reaching a 28-year high of 34.6%, exacerbated by policy reforms including the removal of fuel subsidies and naira devaluation in 2023.

The theoretical context that underpins the relationship between inflation dynamics and petroleum pump price is rooted in a conjuncture of cost-push inflation and monetary theory of inflation. Within this context, inflation occurs when production costs increase, leading firms to pass these costs onto consumers in the form of higher prices. Petroleum pump prices directly affect transportation, manufacturing, and overall production costs. When fuel prices rise, businesses incur higher operational costs, which are then transferred to consumers, increasing distributive effects on overall inflation; thereby threatening the achievement of price stability as a prime objective of monetary policy in Nigeria.

Significant swings have characterized Nigeria's petroleum pump price trajectory, which has been impacted by internal economic considerations, international oil market dynamics, governmental actions, and the ongoing rise in inflation dynamics. According to the NBS (2023) study, the price of gasoline at the pump was about ₦20 per liter in 1999, when democratic administration first began. The cost of a liter had increased to about ₦75 by the end of Obasanjo's government in 2007. Price hikes were suggested in 2012 as part of an attempt to eliminate fuel subsidies, but after massive demonstrations, subsidies were partially restored. After the government of the day made changes between 2022 and the end of the first half of 2023, pump prices rose to about ₦617 per liter. After the fuel subsidy was removed on May 29, 2023, petroleum prices skyrocketed, with reports stating that they reached ₦1,030 per liter.

Many Nigerians' levels of life was impacted by this tendency, which had a cascading effect on the economy by increasing manufacturing and transportation expenses, which in turn fuel inflation. The Nigerian National Petroleum Company Limited (NNPC) has lowered the price of gasoline at some stations to ₦860 per liter from ₦945 per liter. This resulted in gains of 1106% and 53.2%, respectively, from 2012 to 2025 and 2023 to 2025. Dangote Refinery's aggressive pricing tactics and the drop in world oil prices had an impact on this change. A balanced strategy that takes into account public welfare, economic realities, the necessity of sustainable energy policy, and long-term price stability is needed to manage these prices.

Given that inflation has grown to be a significant macroeconomic problem, some studies (Kabundi, 2022; Omotosho & Doguwa, 2022) that look at the relationship between inflation and fuel prices mainly concentrate on how changes in fuel prices affect overall inflation rates rather than the other way around, viewing fuel prices as a major contributor to inflation because of their widespread effects on different economic sectors. According to Arinze (2021), there is a pass-through effect between fuel costs and inflation, meaning that rising retail fuel prices have a direct impact on rising consumer price index (CPI) levels. Different income groups are proportionately impacted by rises in fuel prices. All households may see a reduction in purchasing power as a result of rising gasoline prices, but lower-income populations in developing nations may have a more noticeable and long-lasting effect. Apparently, the most prominent research in the body of existing literature has focused on the relationship between fuel prices and inflation, omitting the short- and long-term dynamic effects of inflation on the price of petroleum pumps, particularly at a time when both inflation and petroleum pump prices are skyrocketing. On this basis, out study set out to estimate the short run and long run distributive lag effects of inflation dynamics on petroleum pump price in Nigeria from 1986 to 2023. The rest of the paper are report in section 2 – which deals with literature review, methodology is treated in section 3, results and discuss presented in sections and section 5 concludes the study.

2. Literature Review

2.1. Review of Theoretical Literature

Several economic theories help explain the determinants and fluctuations of petroleum pump prices. These theories analyze the role of supply, demand, market structures, and external factors in influencing fuel prices in relation to inflation dynamics.

Supply and Demand Theory: Adam Smith and David Ricardo were the main contributors to the development of supply and demand theory, which Alfred Marshall later codified in his 1890 book Principles of Economics. The theory is predicated on the conventional idea of the "invisible hand," which highlights how supply and demand interact in free markets to set pricing. Abdurrauf and Tunde (2020) argue that the price of an item or service is determined by the interaction of supply (producers) and demand (consumers) in a market, supporting the theory's applicability. The theory clarifies how prices adapt to shifting market dynamics, guaranteeing that items are distributed effectively.

In this situation, the equilibrium between supply and demand is what mostly determines the price of gasoline at the pump. Prices typically decline when there is a high supply of petroleum and little demand; prices rise when there is a low supply or rising demand, which raises overall price levels (inflation dynamics). In his research, Bobai (2022) noted that inflation thwarts the macroeconomic attempt to balance production and consumption, which is a natural tendency of pricing in open markets. The idea is essential to understanding how inflation dynamics and gas pump prices are related.

Fuel is an essential component of daily living, transportation, and manufacturing, therefore changes in its price have a big effect on inflation. Given that petroleum is a significant cost driver in the economy, it can be concluded that this theory explains how variations in fuel supply and demand have a direct impact on pump prices. These changes in pump prices also have an impact on inflation dynamics, which in turn affects the cost of living as a whole. Cost-push inflation theory is required to completely explain price changes since, despite being a solid fundamental model, it has certain weaknesses in the production and speculative industries.

Cost-push Inflation Theory: John Maynard Keynes was the main developer of this theory in 1936. Nicholas Kaldor and other Keynesian economists later added to it. According to the hypothesis, inflation happens when firms are compelled to raise prices due to rising production costs, which raises overall price levels. According to this idea, firms raise prices for goods and services as a result of rising production costs, which causes inflation. Cost-push inflation, as opposed to demand-pull inflation, which results from excess demand, is brought on by supply-side factors that raise prices even in the case of stable demand. In contrast to demand-pull inflation, Bawa and Abdullahi (2021) contend that cost-push inflation results from supply-side variables that raise prices even in the presence of stable demand. It happens when companies boost pricing for goods and services due to rising production costs. Bayo (2021) cautions that growing manufacturing costs, supply disruptions, and wage pressures can all contribute to inflation rather than just excessive demand.

According to Adu and Marbuah (2021), rising manufacturing costs have played a major role in the current inflationary tendencies. Petroleum is an input and a crucial part of the cost structure of any industrial process, therefore this makes sense. The complexity of inflation is emphasized by Akinleye and Ekpo (2023), who also stress the importance of cost-push factors like growing wages and production expenses in causing inflationary pressures. The intricate structure of inflation is explained by Abdurrauf and Tunde (2020), who show how cost-push factors, such as rising labor and material prices, can raise price levels. Examining the theory's relative significance, which emphasizes the role of petroleum in production costs that serve as the foundation for determining a product's market value. The theory further underscores the significance of cost-push factors in influencing inflation across different economic contexts including petroleum pump pricing.

Empirical Literature Review

There are some excellent empirical studies on the connection between Nigerian inflation and fuel costs. Abdurrauf and Tunde (2020), Bobia (2022), Sani, Ismaila, and Adamu (2016), and Kabundi (2022) are notable examples of these. The study by Abdurrauf and Tunde (2020), which examined the relationship between the petroleum pump price (PPP) and the consumer price index (CPI) in Nigeria from 2000 to 2019, serves as an example. The study discovered that while the price of kerosene showed a strong inverse influence on consumer prices in the short term but a positive one in the long term, the price of gasoline had a significant direct impact on consumer prices in the short term but no significant impact in the long term. The cross-section short-run coefficient results showed that the manufacturing sector of the economy benefited greatly from gasoline and diesel pricing.

According to Sani, Ismaila, and Adamu's (2016) analysis, average rainfall and historical inflation seems to have been the primary factors influencing Nigeria's inflationary process during the study period. The dominance of the monetarist theory on the dynamics of inflation in Nigeria is further supported by compelling evidence of the role of the money supply in the inflation process. The macroeconomic effects of oil price shocks on Nigeria's macroeconomic performance were also studied by Akinleye and Ekpo (2013). They found that positive oil price shocks have greater short- and long-term effects on real gross domestic product than negative ones, which in turn causes inflationary pressure and depreciation of the local currency as imports rise. According to their analysis, shocks to the price of crude oil can only hinder economic growth in the long term, while they can only slightly raise general prices in the short term, which can result in depreciation of the currency and increased imports.

To determine the primary causes of Uganda's inflation, Kabundi (2022) used a single-equation error correction model based on the quantity theory of money. Money growth, global food prices, domestic supply and demand effects in the agriculture sector, energy prices, and inflation inertia are some of the internal and external factors that impact inflation in Uganda, according to the study. Periods of high inflation volatility were linked to specific government policy changes, food price shocks, and a lack of coordination between fiscal and monetary policies, according to research by Omotosho and Doguwa (2022). They added that the announcement of fuel price hikes, announcement of an upward review in the wages of public sector workers, food crises and exchange rate instability also led to major positive inflationary shocks in the economy.

According to Bobai (2022), there is a positive correlation between inflation, AGO (diesel), and PMS (fuel). However, it was discovered that PMS had a greater impact on inflation than AGO, and that DPK (kerosine) and inflation had a negative association. The entire result makes it abundantly evident that rising petroleum product prices have a major impact on Nigeria's inflation rate. According to Bayo's (2021) research, the money supply, interest rates, exchange rates, and budget deficits all had a major effect on Nigeria's inflation rate.

Real output, nominal exchange rate, broad money supply, nominal interest rate, and fiscal deficit are among the structural and monetary factors that Adu and Marbuah (2011) found to be determinants of inflation after applying the bounds testing approach to empirically examined factors that account for inflation dynamics in Ghana. Arinze (2021) argues that Nigeria's high cost of living, inflation, and unequal income distribution are all consequences of rising petroleum product prices. Additionally, it was discovered that during this time, the different Nigerian regimes raised gasoline prices eighteen times in total. The majority of these increases took place between 1990 and 2007, when prices were modified twice a year, occasionally more frequently. This caused the price of petroleum to rise, which in turn fueled inflation.

The aforementioned makes it clear that documented empirical research has only found that petroleum pump prices (PPP) cause random and unpredictable fluctuations in the market pricing of commodities and services. This line of reasoning has produced a variety of outcomes; some contend that PPP and inflation are positively correlated, while others disagree. Once more, previous research used inflation as a univariant variable, while others used the consumer price index (CPI) as a proxy. These studies concluded prior to 2023, when the PPP and inflation rate experienced a sharp increase. Our research, however, departs significantly from this school of thought. First, we contend that a consistent rise in general prices in both domestic and international markets would force emerging economies to raise the price of the primary commodity in order to generate more income and meet their fiscal obligations.

Secondly, we consider inflation as inflation dynamics and decomposed it into consumer price index (CPI), producer price index (PPI) and food price index (FPI); and also extends the period of study to 2024. Leveraging this argument, PPP is seen as a function of inflation, not the other way round and inflation dynamics are defined in a manner of consumer price index, producer price index and food price index – which is obviously paucity in the body of existing literature. This is the noticeable gap that attracted our attention to unravel the implications of formalized informalities through the estimation of distributive lag effects of inflation dynamics on petroleum pump price in Nigeria from 1986 to 2023. This is the motivation of this study.

3. Methodology

In order to identify any institutionalized informalities in the petroleum pump price trajectory, this work uses an ex-post factor research approach to estimate the distributive lag effects of inflation dynamics on the price of petroleum pumps in Nigeria from 1986 to 2024. The works of Abdurrauf and Tunde (2020), Bobia (2022), and Sani, Ismaila, and Adamu (2016), Kabundi (2022), who examined the relationship between inflation and petroleum pump price (PPP), were taken into consideration, but with some modification. Following supply and demand theory and research showing a negative correlation between inflation rate and PPP, we make the case in opposite order. The thesis is that, the trajectory and tendency to catch up with increasing inflationary trend, in both domestic and international scales, make economies to adjust the price of the product serves as the economic mainstay, in the case of Nigeria, petroleum, in order to meet up with economic realities. Consequently, we construed petroleum pump price (PPP) to be dependent on inflationary trend; hence we specify the functional (theoretical) model as follows:

$$PPP = f(INFD) \qquad 3.1$$

Where: *PPP = Petroleum Pump Price, INFD = Inflation Dynamics*

From the functional relationship, petroleum pump price serves as the dependent variable while inflation dynamics serves as the independent variables and it includes consumer price index, producer price index and food price index. The functional relationship is further specified as:

$$PPP = f(CPI,\ PPI,\ FPI) \qquad 3.2$$

Where: *PPP = Petroleum Pump Price; CPI = Consumer Price Index; PPI = Producer Price Index; and FPI = Food Price Index.*

From equations (3.2) and (3.3) the mathematical model is cast thus:

$$PPP_t = \alpha_0 + \alpha_1 CPI_{t1} + \alpha_2 PPI_{t2} + \alpha_3 FPI_{t3} \qquad 3.3$$

From the mathematical model, the econometric model is specified as follows:

$$PPP_t = \alpha_0 + \alpha_1 CPI_{t1} + \alpha_2 PPI_{t2} + \alpha_3 FPI_{t3} + \mu_t \qquad 3.4$$

Where: *PPP, CPI, PPI and FPI retain their initial definitions, t stands for time series dimension, α_0 as the intercept or constant or the PPP regression model, α_1, α_2 and α_3 are the slopes or the coefficients of the regression line with respect to CPI, PPI and FPI respectively, and μ is the error or stochastic term.*

From equation (3.4) the short run and long forms of autoregressive distributive lag (ARDL) models are estimated accordingly. Before then, it is important to inform that the ARDL models would be estimated by adopting the models in Abdurrauf and Tunde, (2020) and Sani, Ismaila, and Adamu (2016), Kabundi (2022). It is also instructive to point out that the variables of the study would be presented in natural log form to enable assess the performance and the behaviours of the variables on the common scale. The ARDL models are therefore estimated thus:

$$\Delta lnPPP_t = \alpha_0 + \alpha_1 ln\Delta PPP_{1(t-1)} + \alpha_2 ln\Delta CPI_{2(t-1)} + \alpha_2 ln\Delta PPI_{3(t-1)} + \alpha_4 ln\Delta FPI_{4(t-1)}) + \sum_{i=1}^{p} \theta\Delta PPP_{1(t-1)}$$
$$+ \sum_{i=1}^{p} \theta\Delta CPI_{2(t-1)} + \Delta\sum_{i=1}^{p} \theta\Delta PPI_{3(t-1)} + \sum_{i=1}^{p} \theta\Delta FPI_{4(t-1)} + \mu_t \qquad 3.5$$

***Where:** α_0, α_1, α_2, α_3, and α_4 retain their initial definitions. Δ is the vector for change in each of the variable, it is natural log symbol, t - 1 is the lag indicator, $\sum_{i=1}^{p}$ = is the summation as 'i' tends to '1' to 'P', 'ϴ' and Δ are difference operators.*

The methodological procedure adopted follows thus Augmented Dickey-Fuller (ADF) test for establishment of stationarity (Brown, *et al.* 1975 cited in Ratnasiri, 2019), correlation matrix, optimal lag length determination, ARDL Bound Test of Cointegration (Pesaran & Shin, 1999; Pesaran, *et. al.,* 2001 cited in Ratnasiri, 2019), Granger Causality, Post Estimation Tests of normality, heteroskedasticity, serial correlation, cumulative residual (CUSUM), cumulative sum of squares of recursive residuals (CUSUMSQ), and Stability Checks.

The ADF test model is specified: $\Delta Y = \beta^{1} D_t + \pi Y_{t-1} + \sum_{j=1}^{p} \varphi \Delta Y_{t-1} + \varepsilon t$ 3.6

***Where:** $\pi = \phi - 1$ under null hypothesis Δyt is 1(0) which implies that $\pi = 0$, D is a vector of deterministic terms (constant, trend), p lagged difference terms, $\Delta yt\text{-}j$, are used to approximate the ARMA structure of the errors, and the value of p is set so that the error εt is serially uncorrelated. The error term is also assumed to be homoskedastic.*

The ARDL bounds tests are used for two purposes; as an alternative for OLS method and for cointegration testing simultaneously. Empirically, when all variables are in mutual order of integration they are classified as either *I*(1) or *I*(0), while different order of cointegration represent *I*(1) / *I*(0). An ARDL bound testing is relatively more suitable for analysis in any of the cases described above because of its flexibility and dynamic nature. This method helps to determine whether or not the variables of interest converge in the long run indicating the elimination of the short run disequilibrium. The ARDL approach consists of the following equation:

$$\Delta Z = \varepsilon_0 + \varepsilon_1 t + \lambda_1 \delta_{t-1} + \sum_{i-1}^{k} \phi_1 v_{it-1} + \sum_{j-1}^{n} \varphi_j \Delta Z_{t-j} + \sum_{i-1}^{k} \sum_{j-1}^{n} \omega_{ij} \Delta V_{it-j} + \Upsilon D_t + \mu_t \qquad 3.7$$

4. Result Presentation and Discussion

Table 4.1: Result Descriptive Statistics of the Study Variables

	PPP (₦)	CPI (%)	PPI (%)	FPI (%)
Mean	78.08649	19.86351	17.01495	78.03243
Median	65.00000	13.01000	10.51000	77.70000
Maximum	617.0000	72.84000	75.40170	190.1000
Minimum	0.200000	5.390000	0.686100	30.50000
Std. Dev.	106.1394	17.17731	14.77733	30.06328
Skewness	3.641973	1.749175	2.105304	1.210155
Kurtosis	19.10501	4.815621	8.098099	6.315780
Jarque-Bera	481.6585	23.94968	67.40142	25.98062
Probability	0.000000	0.000006	0.000000	0.000002
Observations	38	38	38	38

Source: Authors' Computation, 2025.

Table 4.1 presents the result of descriptive statistical test conducted on the study variables – PPP, CPI, PPI, and FPI. From the result, the PPP has mean value of N78.09. This suggests that, on average, PPP is N78.09 within the period of 38 years, from 1986 to 2023. The value of median is N65.00 which suggests that half of the petroleum pump price (PPP) is below N65.00 while the other half is above the distribution. The maximum value of N617.00 implies the highest value of PPP in the distribution which was recorded in 2023; while the minimum value was recorded in the start year of 1986 at the value of 0.20 kobo. The standard deviation value suggests that PPP varies on the average of N106.14, with positive skewness (3.641973) meaning that the data on PPP skewed to the right.

The kurtosis value of 19,10501 suggests that the dataset contains extreme outliers far from the mean and since value is greater than 3. This it further implies that the distribution is leptokurtic, meaning there is a high probability of extreme values occurring. The value of Jarque-Bera of 481.6585 implies that the dataset extremely strongly deviates from normality with very high confidence but significant as revealed by the probability value (0.0000), which instructively suggests the need for unit root test using logged transformed data – as done and reported subsequently. Table also presents the descriptive statistical result on consumer price index (CPI) with a mean value of 19.86%. This suggests that, on average, CPI is 19.86% within the period of 38 years, from 1986 to 2023. The value of median is 13.01% which suggests that half of the CPI is below 13.01% while the other half is above the distribution. The maximum value of 72.84% implies the highest value of CPI in the distribution recorded in 1995; while the minimum value was recorded in 2007 at the value of 5.39%.

The standard deviation value suggests that CPI varies on the average of 17.18, with positive skewness (1.749175) meaning that the CPI skewed to the right. The kurtosis value of 4.815621 suggests that the dataset contains extreme outliers far from the mean and since value is greater than 3. This further implies that the distribution is leptokurtic, meaning there is a high probability of extreme values occurring. The value of Jarque-Bera of 23.94968 implies that the dataset strongly deviates from normality, because it is greater than 5.99 at 5% level of significance, with very high confidence.

With respect to producer price index (PPI), the table reveals a mean score of 17.01% - which indicates, on average, that PPI is 17. 01% from 1986 to 2023. The value of median is 10.51% - meaning that half of the PPI is below 10.51% while the other half is above the value in the distribution. The maximum value of 75.10% implies the highest value of PPI in the distribution recorded in 1995; while the minimum value was recorded in 2009 at the value of 0.69%. The standard deviation value suggests that PPI varies on the average of 14.78, with positive skewness (2.105304) meaning that the PPI skewed to the right.

The kurtosis value of 8.098099 suggests that the dataset contains extreme outliers far from the mean and since value is greater than 3. This further implies that the distribution is leptokurtic, meaning there is a high probability of extreme values occurring. The value of Jarque-Bera of 67.40142 implies that the dataset strongly deviates from normality, because it is greater than 5.99 at 5% level of significance, with very high confidence. However, it has significant probability value (0.0000). This instructively suggests the need for unit root test using log-transformed data – as done and reported subsequently.

As regards to food price index (FPI), the table reports a mean score of 78.03% - which indicates, on average, that FPI is 78. 01% from 1986 to 2023. The value of median is 77.70% - meaning that half of the FPI is below 77.70% while the other half is above the value in the distribution. The maximum value of 190.10% implies the highest value of FPI in the distribution recorded in 2023; while the minimum value was recorded in 1987 at the value of 30.50%. The standard deviation value suggests that FPI varies on the average of 30.06, with positive skewness (1.210155) meaning that the FPI skewed to the right. The kurtosis value of 6.315780 suggests that the dataset contains extreme outliers far from the mean and since value is greater than 3.

This further implies that the distribution is leptokurtic, meaning there is a high probability of extreme values occurring. The value of Jarque-Bera of 25.98062 implies that the dataset strongly deviates from normality, because it is greater than 5.99 at 5% level of significance. However, it is evident from the results that the four variables (PPP, CPI, PPI and FPI) have significant probability values at 0.0000. This instructively suggests the need for unit root test on the four variables using log-transformed data – as done and reported subsequently.

Table 4.2: Result of Correlation Matrix

	PPP	**CPI**	**PPI**	**FPI**
PPP	1	-0.1884	-0.2977	0.9159
CPI	-0.1884	1	0.8344	-0.3578
PPI	-0.2977	0.8344	1	-0.4083
FPI	0.9159	-0.3578	-0.4083	1

Source: Authors' Computation, 2025.

Table 4.2 presents the result of correlation matrix analyzed to reveal direction and degree relationship between petroleum pump price (PPP), and consumer price index (CPI), producer price index (PPI) and food price index (FPI). From the result, it is evident that PPP is negatively related with CPI and PPI to the values of -0.1884 and -0.2977 (representing approximately 19% and 30%) respectively. However, PPP is positively related with FPI to the value of 0.9159 (approximately 92%). This result simply means that PPP increases as FPI increases. This is instructive because petroleum is a key factor input in agriculture, food production and distribution – higher petroleum prices lead to higher transportation costs, do not make food less expensive. Farming activities also rely on petroleum-based machinery, fertilizers and irrigation systems – so rising petroleum prices increase overall production costs.

Table 4.3: Augmented Dickey-Fuller Unit Root Result

	Dependent Variables						
	At Level			**First Difference**			
Variables	***ADF* Test Statistics**	**t.CV @5%**	**P-value**	***ADF* Test Statistics**	**t.CV @5%**	**P-value**	**Order of Integration**
LNPPP	-2.598821	-3.526609	0.2829	-28.57480	-3.523623	0.0000	**I(1)**
	Independent Variables						
	At Level				**First Difference**		
Variables	***ADF* Test Statistics**	**t.CV @5%**	**P-value**	***ADF* Test Statistics**	**t.CV @5%**	**P-value**	**Order of Integration**
LNCPI	-3.521223	-3.520787	0.0049				**I(0)**
LNPPI	-5.377497	-3.520787	0.0004				**I(0)**
LNFPI	-2.100733	-3.520787	0.5304	-4.860549	3.523623	0.0017	**I(1)**

Source: Authors' Computation, 2025.

Table 4.3 presents the Augmented Dickey-Fuller (ADF) Unit Root test results for the study variables in log form. The dependent variable petroleum pump price (PPP) was non-stationary at level but became stationary after taking the first difference. This indicates that it is integrated of order one, *I*(1). Conversely, among the independent variables, the consumer price index (CPI) and petroleum price index (PPI) were found to be stationary at level, indicating they are integrated of order zero, *I*(0). The food price index (FPI), however, was non-stationary at level but stationary at the first difference, indicating it is *I*(1). The mixed order of integration among the variables (*I*(0) and *I*(1)) justifies the use of Autoregressive Distributed Lag (ARDL) model for estimation. The ARDL approach is particularly suited for this scenario as it can handle variables that are integrated of different orders, making it a robust method for analyzing the long-term equilibrium relationship and short-term dynamics between the dependent and independent variables.

Table 4.4: Lag Order Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: PPP
Exogenous variables: C
Included observations: 34

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-206.9661	NA	12033.39	12.23330	12.27819	12.24861
1	-195.3358	21.89225*	6439.782*	11.60799*	11.69778*	11.63861*
2	-194.5943	1.352317	6540.536	11.62319	11.75787	11.66912
3	-193.8166	1.372248	6630.868	11.63627	11.81585	11.69751

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table 4.4 presents the lag order selection criteria on the study variables – PPP, CPI, PPI and FPI. From the result of the analysis, it is evident that lag period selected is one (1) across the selection criteria such as LR, FPE, AIC, SC and HQ. This implies that the lag point used in the utilization of autoregressive distributive lag in estimating the effects of inflation dynamics on petroleum pump price in Nigeria from 1986 to 2023.

Table 4.5: Result of Short-Term Coefficients of the Estimated ARDL Model

Dependent Variable: LNPPP
ARDL Short-run Model

Variables	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*	*Remarks*
LNCPI	0.021150	0.044614	0.474066	0.6394	***Not significant***
LNPPI	0.051849	0.038560	1.344621	0.1904	***Not significant***
LNFPI	0.460294	0.234147	1.965836	0.0601	***Not significant***
C	-0.290985	0.293515	-0.991380	0.3306	***Not significant***
R-squared	0.780117				
Adjusted R-squared	0.678632				
Prob	0.000008				

(f statistics	
Durbin Watson	2.422791

Source: Authors’ Computation, 2025.

Table 4.5 reports result of the short-term analysis of the estimated ARDL model. The analysis reveals mixed significance levels. With respect to the dependent variable LNPPP (log of petroleum pump price), the coefficients of LNCPI (log of consumer price index), LNPPI (log of producer price index), and LNFPI (log of food price index) are 0.021150, 0.051849, and 0.460294 respectively, but none being statistically significant at conventional levels (p-values > 0.05), though with a high goodness-of-fit. The R-squared value is 0.78117, while the adjusted R-squared values of 0.678632. This suggests that the independent variables explain a substantial portion of the variance in the dependent variable. Put differently, it could be discerned that 78% changes in PPP are attributed to joint interaction of CPI, PPI and FPI, while the remaining 0.21883 is due to factors not included in the model. The Durbin-Watson statistics is 2.422791, indicates that there is no significant autocorrelation in the residuals.

Table 4.6: Result of ARDL Bound Testing Result

F-Bound Test		Null Hypothesis: No levels relationship			
Test statistic	Value	Signif.	*I*(0)	*I*(1)	
				Asymptotic: n=1000	
F-statistic	5.368817	10%	2.37	3.32	
K	3	5%	2.79	3.67	
		2.5%	3.15	4.08	
		1%	3.66	4.65	
Actual sample size	39		Finite sample: n=40		
			10%	2.592	3.454
			5%	3.1	5.544
			1%	4.31	5.444

Source: Authors’ Computation, 2025.

As present in table 4.6, the test result shows an f-statistic of 5.37, which is higher than the critical values at the 5% significance level. This means that there is a significant long-term relationship between inflation dynamics and petroleum pump price in the short run period of analysis. Having confirmed this, we proceeded to the test for a possible long run relationship as reported below:

Table 4.7: Result of Long-Term Coefficients of the Estimated ARDL Model

Dependent Variable: LNPPP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCPI	-0.221880	0.198482	-1.117885	0.2738
LNPPI	0.323513	0.295618	1.094364	0.2838
LNFPI	-0.202270	0.155263	1.302755	0.2041
C	-0.773527	0.813610	-0.950734	0.3505

Source: Authors' Computation, 2025.

Table 4.7 presents the result of long-term coefficient of the estimated ARDL model. From the result, the coefficient for the Consumer Price Index (LNCPI) is -0.2219, suggesting that a 1% increase in the CPI is associated with a 0.2219% decrease in petroleum pump prices in the long run. However, this relationship is not statistically significant (p = 0.2738), indicating a weak influence of consumer price index on specific petroleum pump prices. Similarly, the coefficient for the producer price index (LNPPI) is 0.3235, implying that a 1% increase in the broader index of PPI gave rise to a 0.3235% increase in the specific petroleum pump price; though the result is also not statistically significant (p = 0.2838). Lastly, the coefficient for food price index (LNFPI) is -0.2023, meaning that a 1% increase in FPI is associated with a 0.2023% decrease in the PPP, but this effect is not statistically significant (p = 0.2041).

Table 4.8: Result of Pairwise Granger Causality Test Result for PPP Model

Null Hypothesis:	Obs	F-statistics	Prob.
LNCPI does not Granger cause LNPPP	35	0.19478	0.8239
LNPPP does not Granger cause LNCPI		2.12083	0.1347
LNPPI does not Granger cause LNPPP	35	0.16497	0.8486
LNPPP does not Granger cause LNPPI		6.01328	0.0056
LNFPI does not Granger cause LNPPP	35	2.06429	0.0125
LNPPP does not Granger cause LNFPI		0.03236	0.9682

Source: Authors' Computation, 2025.

Table 4.8 shows that the consumer price index (LNCPI) does not Granger cause the petroleum pump price (LNPPP) as revealed by their probability values of 0.8239 and 0.1347. This indicates that there is no evidence that past CPI helps to predict future PPP. Consequently, the null hypothesis that neither PPP nor CPI does not Granger cause each other retained as evident in the probability values. The table further reports that there is a unidirectional causality from PPP to PPI; which suggests that past events of PPP could help to predict PPI.

This is confirmed by the probability value of 0.0056. it is instructive to point out that petroleum price index influences producer price index, but changes in producer price index do not significantly impact petroleum price index in the given analysis. This result suggests that changes in petroleum pump prices do have predictive power over producer price index. Considering the natural logarithm of the Producer Price Index (LNPPI) and the natural logarithm of Food Prices Index (LNFPI) the results reveals that FPI Granger causes PPP (p-value of 0.0125). this implies that there is a unidirectional causality between FPI and PPP. This means that changes in food price index cause changes in petroleum prices, but not the other way around.

Table 4.9: Result of Diagnostic Check Analysis

Petroleum Pump Price Model			
Residual Normality Test			
Jarque-Bera	5.651024	**Probability**	0.059278
Breusch-Pagan-Godfrey Heteroscedacity Test			
F-statistic	1.001762	Prob. F(12,36)	0.4742
Obs*R-squared	12.33063	Prob. Chi-Square(8)	0.4195
Scaled explained SS	10.17429	Prob. Chi-Square(8)	0.6007
Breusch-Pagan-Godfrey Serial Correlation LM Test			
F-statistic	1.488476	Prob. F(2,24)	0.2458
Obs*R-squared	4.303716	Prob. Chi-Square(2)	0.1163
Specification and Stability test			
	Value	Df	Probability
t-Statistcs	0.093257	33	0.9263
F-statistic	1.947616	(1, 33)	0.9623

Source: Authors' Computation, 2025.

In table 4.9, the residual normality test using Jarque-Bera statistics shows a probability of 0.059278, suggesting a borderline acceptance of normality. The Breusch-Pagan-Godfrey tests indicate no significant heteroscedasticity, with p-values for the F-statistic, Obs*R-squared, and Sca 4195, and 0.6 LM Test sup 0.1163 for Obs h p-values of with the Petr nd 0.3119, resp of 0.7702, this ese results collectively suggest that the model's assumptions are largely met.

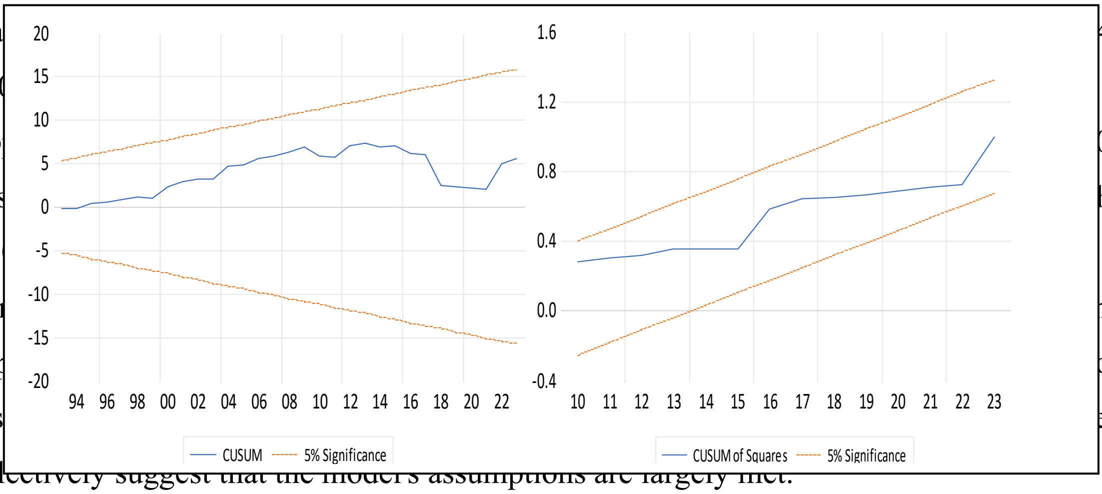

Figure 4.1: CUSUM and CUSUM Square Test for the Study Variables
Source: Authors' Design, 2025.

Discussion of Findings Implications for Formalized Informalities

In order to examine potential institutionalized informalities in the Nigerian markets' pricing system, the dataset was utilized to estimate the distributive lag effects of inflation dynamics on the price of petroleum pumps in Nigeria. The ARDL model result from the investigation demonstrates clear short-term dynamics. The coefficients for FPI (0.460294), PPI (0.051849), and CPI (0.021150) for the petroleum pump price (LNPPP) are not statistically significant, indicating no short-term impact. Petroleum pump prices are not considerably impacted over the long term by the CPI, PPI, or FPI. Granger causality studies demonstrate that while inflation does not predict pump prices, gasoline pump prices do. While inflation and minimum wage rates do not predict one another, changes in the minimum wage are largely predicted by the Producer Price Index and the Food Price Index.

According to the findings, changes in general consumer prices do not significantly affect petroleum pump prices in the analysis provided since the Consumer Price Index (CPI) has a non-significant impact on these prices. Nonetheless, the formalized informalities are interpreted in such a way that, in practice, economic distortions, regulatory actions, or informal market dynamics may still be involved. This may be the reason why CPI has no effect on the price of petroleum pumps since these are informal or unofficial economic mechanisms (such as uncontrolled, unofficial, or non-institutionalized economic activity) that have been accepted inside formal institutions.

Since the Consumer Price Index (CPI) has a non-significant impact on petroleum pump prices, the analysis's findings indicate that changes in consumer prices generally have little bearing on petroleum pump prices. The institutionalized informalities are interpreted, nevertheless, in the sense that economic distortions, regulatory actions, or informal market dynamics may still be at play in this scenario. These informal or unofficial economic mechanisms - such as uncontrolled, unofficial, or non-institutionalized economic activities - have grown accepted within formal institutions, which may be the reason why the price of petroleum pumps is not greatly impacted by CPI. A classic example is the case of Nigeria, in May 2023, when, on the inauguration of the present administration, the President announced the removal of fuel subsidies, fuel significantly surged before the implementation of the policy shift. This formally normalized an informal market disconnection between CPI and fuel prices.

The study's findings also showed that the producer price index has no discernible impact on the price of petroleum pumps. This implies that variations in production costs have no direct impact on petroleum pump prices (PPP) in this scenario. Because petroleum is a factor input and the long-term results show that PPP and PPI move in the same direction, this is tenable in economic discourse (see table 4.7). However, the apparent weakness of this link may be explained by market distortions, regulatory frameworks, and informal economic mechanisms (0.323513). This finding is in line with research by Olusegun (2018) and Durevall (2018), who contend that informal activities become formalized informalities - unofficial mechanisms that influence the formal economic structure - when they become generally accepted and normalized. Due to economic distortion brought about by black market operations in the fuel-energy market, market forces and policy now jointly set petroleum prices rather than just policy.

Another significant established informality that reduces the responsiveness of production cost (ppI) to the price of petroleum at the pump is the smuggling of fuel across international borders and the informal petroleum markets. People smuggle fuel to sell in nearby markets at higher prices in nations where fuel is cheaper due to subsidies (Sani, Ismaila & Adamu, 2016). Because the informal gasoline trade controls pricing, this maintains domestic prices artificially steady even as production costs increase and keeps the official pump price separate from the PPI. Governments may eventually ignore this practice or implicitly condone it, formalizing it as an informality and institutionalizing it as a common pricing policy.

Additionally, the analysis shows that the food price index is not significantly impacted by changes in the price of gasoline pumps over the long term. This demonstrates that changes in the price of petroleum pumps do not have a substantial impact on food costs in the current economic environment. Numerous structural, policy, and market factors may have contributed to this outcome, suggesting that other elements - such as supply chain interruptions, business expectations, business climate, and agricultural policies - that were not included in the study variables are probably the main causes of food inflation. Qayyum (2016) supports this study by arguing that in emerging economies like Nigeria, where food production is localized, factors like climate change, input costs (seeds, fertilizers), exchange rates, subsidies, agricultural policies, efficient transportation systems, informal market dynamics, time lags in price adjustments, or most likely business expectations may have a greater impact than transportation costs (driven by petroleum pump prices).

In a similar vein, Hyndman and Athanasopoulos (2023) note that subsidies reduce the anticipated pass-through effect of fuel costs in an economic scenario where food prices are mostly unaffected by increases in petroleum pump prices. Serious economic, social, and political repercussions result when government monies meant to promote public welfare are misappropriated, misused, or siphoned off through corruption, inefficiency, or informal markets, as is the case in Nigeria. The presence of informal procedures or market flaws that might lead to a highly segmented food price index is another example of formalized informality. This creates an economic situation where informal pricing mechanisms do not reflect direct input cost changes, and traders, middlemen, and wholesalers may absorb cost fluctuations rather than passing them directly to consumers.

Greenidge and DaCosta (2019) reinforce this result by arguing that traders may adjust food prices based on demand rather than petroleum pump costs in nations with robust informal markets. In other words, food prices can be influenced by hoarding and speculative behavior separately from changes in the price of petroleum pumps. Unregulated, unofficial, or non-institutionalized economic activities that function outside of formal systems but yet have an impact on economic outcomes are all considered formalized informal economic mechanisms. These mechanisms frequently arise as a result of socioeconomic circumstances, inefficient markets, or flawed government policies.

5. Conclusion and Recommendations

Estimating pass-through effects of fuel prices on inflation has dominated economic literature in recent times. This is because the direction of argument in the existing body of literature sees fuel as an input factor that contributes to production cost of goods and services and easily leads to inflation. However, there is obvious paucity of literature on the argument that countries may, in course of meeting revenue target, decide to increase the price of the product that serves as economic mainstay – in the Nigerian case, petroleum. Accordingly, this study estimated the distributive lag effects of inflation dynamics on petroleum pump price in Nigeria – on the basis that changes in any one indicators of inflation dynamics (consumer price index (CPI), producer price index (PPI) and food price index, (FPI)) do not have instantly affect petroleum pump price, but becomes evident gradually over several months or quarters.

In this context, the study utilized data from Central Bank of Nigeria from 1986 to 2023, and methods of data analysis such as Augmented Dickey-Fuller (ADF), correlation matrix, optimal lag length determination, ARDL bound test of cointegration, and Granger causality. Based on the analysis, the result revealed that the coefficient values of CPI, PPI and FPI are 0.021150, 0.051849, and 0.460294 respectively, but none being statistically significant at conventional levels (p-values > 0.05) and the R-squared value is 0.78117, while the adjusted R-squared values of 0.678632. There is a significant short-term effect of inflation dynamics on petroleum pump price, but significant long-term effect failed to exist. There is a unidirectional causality from PPP to PPI as revealed by the Granger causality test result. Based on this, it is concluded that inflation dynamics only have distributive lag effects on petroleum pump price in the short run, but not in the long-term.

Therefore, rather than only eliminating fuel subsidies, government interventions to reduce food petroleum pump prices should concentrate on regulating the operations of the informal sector in the oil and gas sub-industry. In order to mitigate the effects of global oil price fluctuations, the government should also establish a fund for the stabilization of fuel prices, use buffer stocks of refined petroleum to manage supply shocks, reduce immediate inflationary shocks by implementing a graduated fuel pricing system, invest in local refinery capacity to lessen reliance on foreign oil markets, encourage private sector participation in refining and distribution, digitize and monitor subsidy disbursement to prevent corruption and leaks, and phase out generalized fuel subsidies while putting social safety nets in place for vulnerable groups.

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