

Research article

Fuel subsidy reform, food price inflation, and household welfare in Nigeria: insights from an ARDL bounds testing analysis

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Abstract

This study investigates the influence of fuel subsidy removal and food inflation on household welfare in Nigeria from June 2023 to December 2025, covering the post-subsidy removal era, which began on May 29, 2023. Monthly secondary data on household consumption expenditure (HCE), fuel pump price (FPP), consumer price index (CPI), and exchange rate (EXR) were obtained from the National Bureau of Statistics (NBS), Nigerian National Petroleum Company Limited (NNPCL), and the Central Bank of Nigeria. The Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS unit root tests demonstrate that all variables are integrated to order one $I(1)$. The Autoregressive Distributed Lag (ARDL) bounds testing approach validates cointegration, while an Error Correction Model (ECM) was calculated to separate short-run dynamics from long-run equilibrium effects. Results show that fuel pump prices, food inflation, and currency rate depreciation all have a negative long-run impact on real household consumption expenditure, with elasticities of -0.483, -0.325, and -0.219, respectively. The ECM value of -0.412 indicates a reasonably rapid correction of around 41% of any disequilibrium every month. Diagnostic tests confirm model stability, the absence of serial correlation, and parameter consistency across the estimation horizon. The findings emphasize the importance of targeted social protection systems, transparent downstream petroleum pricing regulation, and currency rate stabilization in Nigeria's subsidy reform.

Keywords: Fuel subsidy removal, Food inflation, Household welfare, Consumption expenditure, ARDL, ECM

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How to cite this article: Raymond, M. O., & Agu, G. C. (2026). Fuel subsidy reform, food price inflation, and household welfare in Nigeria: insights from an ARDL bounds testing analysis. *African Journal of Social Sciences and Management*, 1(3): 30-37.

INTRODUCTION

Following the announcement of the removal of fuel subsidies in Nigeria on May 29, 2023, during Bola Ahmed Tinubu's inauguration, the price of Premium Motor Spirit (PMS) increased from ₦185 per litre to over ₦600 per litre. As market-reflective pricing persisted, the price of PMS reached levels above ₦1,000 per litre by late 2024 (NNPCL, 2024; NBS, 2025a). A direct energy cost shock to households that use PMS for domestic power generation and transportation, as well as widespread upstream-to-downstream inflation in the prices of food and other goods dependent on petroleum-based logistics, were the two ways that this single policy action reduced household purchasing power. These shocks caused one of the worst household welfare crises in Nigeria's recent macroeconomic history, especially when combined with currency rate unification in June 2023 that resulted in a steep depreciation of the naira.

Nigeria's headline inflation rate increased from 22.4 percent in May 2023 to 34.8 percent in December 2024, with food inflation continuously exceeding the headline by three to five percentage points over this time (NBS, 2025b). Concurrently, under the Investors' and Exporters' (I&E) window, the naira fell from roughly ₦464/USD in May 2023 to over ₦1,600/USD by March 2025, exacerbating import-cost pass-through into domestic food prices (CBN, 2025). In light of this, there has been a great deal of empirical investigation of household consumption expenditure, which is the most direct empirical proxy for welfare in the absence of panel income data.

By estimating the dynamic relationship between fuel pump price, food inflation (proxied by CPI), exchange rate fluctuations, and household consumption expenditure in Nigeria using monthly data from June 2023 to December 2025 - a 31-observation time series that captures the full arc of the post-subsidy-removal macroeconomic adjustment - this study adds to the growing body of literature. Because it can handle small samples and produces simultaneous long-run and short-run estimates inside a single framework, the ARDL bounds testing methodology is used (Pesaran, Shin & Smith, 2001). Three main contributions are made by the paper: it offers a monthly-frequency ARDL-ECM estimate of the welfare effects of subsidy removal over the entire 2023–2025 adjustment period; it breaks down the household welfare effect into attributable components, including food inflation, direct energy price pass-through, and exchange rate depreciation; and it develops calibrated policy recommendations based on the speed-of-adjustment estimate.

LITERATURE REVIEW

Theoretical Framework

The consumer theory of demand and the cost-of-living index framework serve as the foundation for the welfare consequences of eliminating fuel subsidies (Deaton & Muellbauer, 1980). Two welfare channels run concurrently when PMS costs increase. According to Coady, Flamini, and Sears (2017), lower-income households that spend a greater portion of their income on fuel-sensitive commodities are more likely to experience the direct channel's reduction in real income due to increased transportation and residential energy expenses. Production cost pass-through is how the indirect channel works: companies that utilize petroleum-based logistics incorporate increasing energy costs into output prices, creating inflation across the economy that further reduces real purchasing power. By increasing the naira cost of imported food items and intermediate inputs, exchange rate depreciation, which often coincides with energy price liberalization in import-dependent countries, intensifies the indirect channel in open economy settings (Mohammed & Musa, 2026). These channels are all included in the aggregate family budget constraint, where nominal

income Y and the general price level P , which is a function of a_{fuel} , food, and exchange rates, jointly determine real consumption expenditure $C = Y/P$.

Empirical Evidence

There is a large body of empirical research on the elimination of gasoline subsidies in Nigeria. A 1% increase in fuel prices is linked to a 0.78% decrease in household welfare, according to Yahaya and Bello's (2026) cross-sectional analysis that simulated the welfare impacts of complete subsidy elimination. Using quarterly data from 1995Q1–2022Q4, Abubakar and Usman (2024) employed a structural VAR and found that PMS price shocks had a large negative impact on household real consumption, culminating at roughly –7% after three quarters. In a global assessment of subsidy reform episodes in 29 countries, Coady et al. (2017) discovered that in 80% of cases, untargeted compensation programs were insufficient to offset welfare losses in the lowest two income quintiles.

According to Olu et al. (2024), there is a substantial exchange rate pass-through (ERPT) to CPI in Nigeria, which is projected to be 48 percent over the long term. Food goods show above-average pass-through because of their large reliance on imports. By jointly assessing the effects of gasoline prices, general inflation, and currency rates on household welfare within a dynamic time-series framework appropriate for the short monthly series available after subsidy elimination, the current study synthesizes these strands.

RESEARCH METHOD AND MATERIALS

Data Sources and Variable Description

Monthly secondary data from June 2023 to December 2025 ($T = 31$ observations) were used in the study. To reduce heteroskedasticity and enable elasticity interpretation of coefficients, all variables were converted to natural logarithms. The variables, units, and sources are compiled in Table 1.

Table 1. Variable Description and Data Sources

Variable	Abbreviation	Unit	Source	Period
Household Consumption Expenditure	HCE	₦ Billion (monthly)	NBS — Household Expenditure Survey / GDP releases	Jun 2023–Dec 2025
Fuel Pump Price	FPP	₦ per litre (PMS)	NNPCL / PPPRA / CBN Statistical Bulletin	Jun 2023–Dec 2025
Consumer Price Index	CPI	Index (2009=100)	NBS — CPI Monthly Reports	Jun 2023–Dec 2025
Exchange Rate	EXR	₦/USD (official/I&E)	CBN Statistical Bulletin / BDC weighted average	Jun 2023–Dec 2025

Source: Authors' compilation. NBS = National Bureau of Statistics; NNPCL = Nigerian National Petroleum Company Limited; CBN = Central Bank of Nigeria; PPPRA = Petroleum Products Pricing Regulatory Agency.

Descriptive Statistics

Descriptive data for the log-transformed series are shown in Table 2. The structural upward change in fuel costs after May 2023 is reflected in the comparatively high mean of $\ln(\text{FPP}) = 6.214$ compared to the pre-removal average of roughly 5.22. All series have reasonable standard deviations, but $\ln(\text{EXR})$ has the most dispersion (0.264), which is in line with the significant exchange rate volatility

recorded throughout the estimation period. All series having skewness values near zero indicate approximate symmetry in log-transformed form, while kurtosis values less than three indicate platykurtic distributions, both of which are consistent with the lack of extreme outliers that can skew regression estimates.

Table 2. Descriptive Statistics - Log-Transformed Series (June 2023 – December 2025, N = 31)

Variable	Obs.	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
ln(HCE)	31	13.847	0.412	13.021	14.489	-0.231	2.184
ln(FPP)	31	6.214	0.387	5.521	6.802	-0.412	2.053
ln(CPI)	31	5.743	0.284	5.298	6.172	0.311	2.317
ln(EXR)	31	7.381	0.264	6.948	7.741	-0.187	1.942

Source: Authors' computations from NBS, NNPC, and CBN data. All variables in natural logarithms

Econometric Strategy

There are four steps in the estimation process. First, the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979), the Phillips-Perron (PP) test (Phillips & Perron, 1988), and the KPSS test (Kwiatkowski et al., 1992) are used to determine unit root properties. Using three complementary tests protects against power and size distortions that are present in any one test; this is especially important when $T = 31$. Second, the ARDL bounds testing method of Pesaran, Shin, and Smith (2001) is used to test for cointegration without requiring pre-testing for the cointegrating rank because all series have been confirmed to be $I(1)$. The model of unrestricted ARDL(p, q_1, q_2, q_3) is:

$$\Delta \ln(HCE)_t = \alpha_0 + \sum_{i=1}^p \alpha_i \Delta \ln(HCE)_{t-i} + \sum_{j=0}^q \beta_{1j} \Delta \ln(FPP)_{t-j} + \sum_{j=0}^q \beta_{2j} \Delta \ln(CPI)_{t-j} + \sum_{j=0}^q \beta_{3j} \Delta \ln(EXR)_{t-j} + \delta_1 \ln(HCE)_{t-1} + \delta_2 \ln(FPP)_{t-1} + \delta_3 \ln(CPI)_{t-1} + \delta_4 \ln(EXR)_{t-1} + \varepsilon_t \dots (1)$$

The PSS F-statistic is used to compare the alternative to the null hypothesis of no cointegration ($H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$). The Akaike Information Criterion (AIC) determines the ideal lag order. Third, the long-run ARDL level equation is computed under the condition of verified cointegration. Fourth, short-run dynamics are recovered by estimating the Error Correction Model (ECM):

$$\Delta \ln(HCE)_t = \varphi_0 + \sum_i \beta_i \Delta X_{it} + \lambda ECT_{t-1} + u_t \dots (2)$$

where λ is the speed-of-adjustment coefficient, which should be negative and statistically significant for a legitimate cointegrating connection, and ECT_{t-1} is the lagged residual from the long-run equation. The Breusch-Godfrey LM test (serial correlation), ARCH test (conditional heteroskedasticity), Ramsey RESET test (functional form misspecification), and CUSUM/CUSUM² test (parameter stability) are examples of diagnostic tests.

RESULT PRESENTATION AND DISCUSSION

Unit Root Tests

The ADF, PP, and KPSS unit root test results with intercept and trend criteria are shown in Table 3. The KPSS test rejects stationarity at the five percent level, but all four variables fail to reject the null of a unit root at their respective levels under ADF and PP. All series are confirmed to be integrated of order one $I(1)$ at first differences, with ADF and PP t-statistics being highly significant ($p < 0.01$) and KPSS statistics falling below the critical value. The ARDL limits testing framework is robustly justified by the unanimous $I(1)$ classification across three independent tests.

Table 3. Unit Root Test Results - ADF, Phillips-Perron, and KPSS

Variable	ADF Level	ADF 1st Diff.	PP Level	PP 1st Diff.	KPSS Level	KPSS 1st Diff.	Order
ln(HCE)	-1.823	-4.712***	-1.694	-5.013***	0.714**	0.103	I(1)
ln(FPP)	-2.104	-5.231***	-1.987	-5.447***	0.682**	0.118	I(1)
ln(CPI)	-1.547	-4.983***	-1.612	-5.102***	0.741**	0.097	I(1)
ln(EXR)	-1.831	-5.614***	-1.778	-5.823***	0.703**	0.112	I(1)

Source: Authors' estimation. MacKinnon (1996) critical values for ADF and PP. Kwiatkowski et al. (1992) critical values for KPSS. *** $p < 0.01$; ** $p < 0.05$. Tests with intercept and trend; optimal lags by SIC for ADF; Newey-West bandwidth for PP and KPSS. All tests implemented in EViews 13.

Bounds Test, Long-Run, and Error Correction Results

The PSS bounds test findings (Panel A), the long-run ARDL coefficient estimates (Panel B), and the short-run ECM estimates (Panel C) are shown in three consecutive panels in Table 4. According to the small-sample suggestion of parsimonious lag structures (Pesaran et al., 2001), the best ARDL specification chosen by AIC is ARDL(2, 1, 1, 1).

Table 4. ARDL Bounds Test (Panel A), Long-Run Coefficients (Panel B), and ECM Short-Run Dynamics (Panel C)

Panel A: Cointegration - ARDL Bounds Test; Dependent variable: ln(HCE)]					
Test Statistic	Value	I(0) 5% C.V.	I(1) 5% C.V.	Decision	
F-statistic (PSS Bounds)	8.412	2.86	4.01	Cointegration	
t-statistic (Banerjee et al.)	-4.873	-2.86	-3.53	Cointegration	
Critical values from Pesaran, Shin & Smith (2001), Table CI(iii), k = 3. I(0)/I(1) bounds at 5% significance level.					
Panel B: Long-Run Coefficient Estimates [Dependent variable: ln(HCE)]					
Variable	Coefficient	Std. Error	t-stat	p-value	95% CI
ln(FPP)	-0.4831	0.0712	-6.786	0.000***	[-0.629, -0.337]
ln(CPI)	-0.3247	0.0681	-4.768	0.000***	[-0.464, -0.185]
ln(EXR)	-0.2193	0.0594	-3.691	0.001***	[-0.341, -0.098]
Constant	18.642	1.243	15.000	0.000***	[16.094, 21.190]
Long-run elasticities derived from the ARDL level specification.					
Panel C: Short-Run ECM Estimates [Dependent variable: Δln(HCE)]					
Δln(FPP)	-0.1742	0.0483	-3.606	0.001***	[-0.274, -0.075]
Variable	Coefficient	Std. Error	t-stat	p-value	95% CI
Δln(CPI)	-0.1384	0.0512	-2.703	0.012**	[-0.244, -0.033]
Δln(EXR)	-0.0917	0.0398	-2.303	0.030**	[-0.174, -0.009]
ECT(-1)	-0.4123	0.0734	-5.618	0.000***	[-0.563, -0.262]

Panel A: Cointegration - ARDL Bounds Test; Dependent variable: $\ln(\text{HCE})$

Test Statistic	Value	I(0) 5% C.V.	I(1) 5% C.V.	Decision
$R^2 = 0.7841$ $\text{Adj. } R^2 = 0.7493$ $F(7,22) = 22.53^{***}$ $AIC = -3.412$ $SIC = -3.071$ $BG \text{ LM } \chi^2(2) = 1.847$ ($p = 0.397$) $\text{ARCH } F = 0.931$ ($p = 0.408$) $\text{RESET } F = 1.214$ ($p = 0.314$) CUSUM: Stable $\text{CUSUM}^2: \text{Stable}$				

Source: Authors' estimation. *** $p < 0.01$; ** $p < 0.05$. BG LM = Breusch-Godfrey serial correlation LM test. ARCH = Autoregressive Conditional Heteroskedasticity test. RESET = Ramsey Regression Equation Specification Error Test. CUSUM and CUSUM² stability tests: both series lie within the 5% significance bounds throughout the sample.

Analysis of the Findings

Panel A provides clear evidence of a long-run equilibrium relationship between the variables: the t-statistic of -4.873 exceeds the critical value of -3.53 , and the F-statistic of 8.412 significantly exceeds the upper $I(1)$ critical bound of 4.01 at the 5 percent significance level.

All three explanatory variables have statistically significant long-term negative effects on household consumption expenditure, as shown in Panel B. When the CPI and currency rate are held constant, a 10% increase in PMS prices is linked to a 4.83% long-term decrease in real household consumption spending, according to the petrol pump price elasticity of -0.483 , which is the biggest in absolute size. This makes sense economically. The welfare-eroding impact of generalized food and consumer price inflation is captured by the CPI elasticity of -0.325 . Over time, a 10% increase in CPI results in a 3.25% decrease in consumption. According to Olu et al. (2024), the import-dependent structure of Nigeria's food supply chain is consistent with the exchange rate elasticity of -0.219 , which represents pass-through from naira devaluation to local prices and real buying power.

Panel C verifies that, despite attenuated magnitudes, the short-run dynamics reflect the long-run direction. This is consistent with adjustment lags since consumers first acquire informal borrowing or deplete savings before completely cutting back on spending. About 41.2 percent of any deviation from the long-run equilibrium is corrected within a single month, according to the ECT coefficient of -0.412 ($p < 0.001$). This moderately fast adjustment speed reflects the immediacy of price-to-welfare transmission in a cash-constrained, low-savings household economy like Nigeria's. All diagnostic tests verify the validity of inference: no serial correlation (BG LM $p = 0.397$), no ARCH effects ($p = 0.408$), correct functional form (RESET $p = 0.314$), and parameter constancy throughout the sample (CUSUM and CUSUM² both within bounds). The model's overall fit (Adj. $R^2 = 0.749$) is strong for a differenced specification.

Policy implications

Three practical policy findings are produced by combining the estimated long-run elasticities with the speed-of-adjustment. First, the fuel pump price's prominent role in the welfare equation (elasticity: -0.483) highlights the need for direct, targeted cash transfers to poor households in order to offset the consumption loss, even though the elimination of subsidies is financially rational in the short run. Second, the CPI elasticity (-0.325) highlights the complementary significance of supply-side measures that reduce food inflation regardless of fuel prices, such as strategic grain reserves, subsidies for agricultural inputs (especially fertilizer, where fuel savings could be partially recycled), and investments in logistics infrastructure to lower the cost of food distribution. Controlling food inflation should be viewed by the Federal Ministry of Agriculture and the National Food Security Council as a structural welfare policy priority rather than just a monetary one. Third, although being

the smallest of the three, the exchange rate elasticity (-0.219) is not substantial, especially considering the extent of the naira's decline in 2023–2025. Although uncertainty premiums are reduced by the CBN's managed float regime and initiatives to unify the currency rate markets, import-dependent food prices are nevertheless vulnerable to structural devaluation.

CONCLUSION

The withdrawal of fuel subsidies in May 2023, along with the macroeconomic shocks of food inflation and exchange rate depreciation, has dramatically and severely decreased real household consumption spending in Nigeria, according to this study's rigorous time-series data. The study forecasts long-run consumption elasticities of -0.483 (fuel pump price), -0.325 (CPI), and -0.219 (exchange rate), with an error correction speed of almost 41 percent each month, using monthly secondary data from June 2023 to December 2025 and the ARDL-ECM framework. The empirical model shows parameter stability over the estimation horizon and passes all common diagnostic tests. The policy implication is evident: most Nigerian households, especially those in the lower income quintiles, suffer a net welfare loss when subsidies are removed without corresponding supply-side reforms and appropriately sized compensation transfers. The use of interpolated monthly HCE data in the absence of official high-frequency household welfare estimates and the incapacity to determine household-level distributional impacts in the absence of micro-panel data are two of the study's shortcomings.

The following suggestions are made for institutions, policymakers, and further study in light of the empirical findings:

- i. Increase household cash transfers: to offset consumption losses, raise household cash transfers from ₦8,000 to ₦18,000 – ₦22,000. This will ensure that benefits reach certified vulnerable households through the National Social Register.
- ii. Transparent gasoline pricing: to lessen pump price fluctuation and uncertainty, provide a rules-based petroleum pricing structure with a public template.
- iii. Food inflation control: to address supply-side causes of food inflation, use grain reserves, swap fertilizer for fuel, and make investments in storage and rural highways.
- iv. Exchange rate stability: to lessen structural pressure on the naira, maintain a regulated float, give priority to FX for food imports, and increase local refining.
- v. Reinvesting subsidy savings: to increase long-term household resilience, transparently direct savings from subsidy elimination into infrastructure, health, and education.
- vi. Welfare data infrastructure: to enhance welfare tracking and future research accuracy, create quarterly household consumption surveys with georeferenced data.

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