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Fuel Subsidy Payments and Food Inflation in Nigeria

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Abstract
This study examined the impact of fuel subsidy payments on domestic food price inflation in Nigeria from 2015-2022. Rising and volatile food inflation amid high fuel subsidy expenditures motivated an analysis of their linkage. An Autoregressive Distributed Lag (ARDL) model was estimated using quarterly time series data on fuel subsidy payments, global crude oil prices, agricultural productivity, per capita income, and food inflation. The results provide evidence of a statistically significant negative relationship between fuel subsidies and food inflation, both in the short and long run. The model estimates that reducing fuel subsidies transmits into higher domestic food prices within a quarter itself. Global oil prices positively impact food inflation by raising production and transport costs over time. Agricultural productivity reduces food inflation sustainably by encouraging greater output. Per capita income increases food inflation via higher demand. Overall, the findings align with the theoretical framework of cost-push drivers of food inflation. Gradual subsidy reform is recommended, coupled with investments in agriculture, social transfers for low-income households, economic diversification, and prudent monetary policy to mitigate risks of inflationary shocks.
Keywords: Fuel subsidies, Food inflation, Crude oil prices, Agricultural productivity, ARDL model
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1. Introduction

Nigeria has experienced a long history of providing substantial subsidies on gasoline and diesel to keep fuel prices low for consumers. However, the sizable fiscal burden led the government to initiate various reform efforts to deregulate fuel prices, albeit with limited success (Ozili & Obiora, 2023; International Monetary Fund [IMF], 2023). Fuel subsidies re-emerged during periods of high oil prices up till the 2015-2016 global oil crash. In early 2015, the new administration raised fuel prices to curb subsidy spending, but subsequent shortages and public opposition forced a reversal, and subsidies continued albeit at lower world oil prices (McCulloch, Moerenhout & Yang, 2021). As oil markets recovered post-2016, subsidy costs rose, reaching unsustainable levels by 2022.

Consequently, reducing or removing fuel subsidies has significant economic implications that must be carefully managed. A major concern is the potential impact on domestic food price inflation (Amaglobeli, Hanedar, Hong & Thevenot, 2023; Adeniran, 2016). Global fuel and food price spikes from supply chain disruptions during the pandemic further underscore this linkage (Hirvonen, Brauw & Abate, 2021; Mahajan & Tomar, 2020). In Nigeria, fuel costs affect farm expenses like irrigation, machinery use and transportation of agricultural inputs (IMF, 2023). Higher fuel prices following lower subsidies can feed into the costs of food production, processing, storage and distribution. This may transmit to higher domestic consumer food prices, negatively impacting household welfare (Gao, Erokhin & Arskiy, 2019).

Available data from the Central Bank of Nigeria [CBN] (CBN, 2023), show that food inflation in Nigeria exhibited an overall increasing trend from 2015:Q1 to 2022:Q3, but with some fluctuations over the period. In 2015, food inflation rose at a steady pace from 172.84 in Q1 to 186.20 by Q4. There was a spike in 2016 Q2 to 205.39, followed by more modest step-ups in the subsequent quarters of that year. The upward trend persisted into 2017, with food inflation accelerating from 230.80 in Q1 to 261.01 by Q4 as price pressures built up. The inflationary escalation continued through 2018 and 2019 as well, with food inflation reaching 339.88 by 2019 Q4. In 2020, there were larger jumps in food inflation, especially in Q3 (382.72) and Q4 (406.36) coinciding with supply chain disruptions from the COVID-19 pandemic. This inflationary momentum accelerated even further in 2021, ending the year at a high of 476.95 in Q4. By 2022 Q3, food inflation had surged to 564.40, representing the highest level over the 2015-2022 period examined. The data indicate that food inflation in Nigeria intensified each year from 2015 to 2022 Q3, exhibiting periodic spikes, and an overall steepening of the upward trajectory, especially from 2020 onwards in the face of global shocks. This rising food inflation trend provides useful context and motivation for analyzing the drivers, like changes in fuel subsidy policy that could be influencing domestic food price dynamics over this time period.

Similar data on fuel subsidy payments gotten from PricewaterhouseCoopers [PwC] (2023), indicate that fuel subsidy payments by the Nigerian government exhibited substantial fluctuations from 2015 to 2022. In 2015, fuel subsidy payments were ₦654 billion. This declined steeply in 2016 to ₦246 billion as low global oil prices provided some temporary relief. Subsidy payments continued falling in 2017, dropping further to ₦145 billion. However, in 2018, there was a sharp reversal of this downward trend, with subsidies skyrocketing to ₦1.19 trillion, as international crude prices started recovering. Subsidy spending moderated somewhat in 2019 to ₦0.5 trillion but remained elevated compared to earlier years. In 2020, subsidies rose again to ₦ 0.9 trillion amid increasing world oil prices. 2021 saw a massive jump to ₦1.4 trillion spent on fuel subsidies as the global economy rebounded from the pandemic downturn. By 2022, subsidy payments had surged to an unprecedented ₦4.4 trillion, representing the highest spending over the 2015-2022 period examined. Although subsidy outlays declined in 2016-2017 with lower oil prices, they rebounded thereafter reaching fiscally unsustainable levels by 2021-2022 when crude prices spiked. This volatility in fuel subsidy expenditures provides useful context when examining the relationship between Nigeria's subsidy policy shifts and dynamics in domestic food price inflation over this timeframe.

Quantifying the pass-through effect of subsidy payments to food prices is crucial for policy analysis on fuel subsidy reforms. Complementary social transfers can mitigate the impact on low-income citizens who spend a large share of income on food (Amaglobeli et al. 2023). A nuanced understanding of distributional outcomes can shape the optimal design of subsidy reductions. Additionally, the current literature on fuel subsidies in Nigeria does not thoroughly examine the specific effects of fuel subsidy payments on nationwide food price inflation. For example, Ozili and Obiora (2023) broadly analyzed the macroeconomic results of removing fuel subsidies but did not empirically study the downstream impacts on food inflation. While McCulloch et al. (2021) focused on how subsidy removal affects different households, their research did not quantify the inflationary impacts on domestic food prices. Models like Omotosho (2019) included fuel prices but did not directly analyze how varying subsidy scenarios influence food inflation. Sectoral analyses like Harun et al. (2018) looked at production cost impacts of removing subsidies, but only for non-agricultural sectors, without considering agriculture and food industries. Besides, Akinyemi et al. (2017) study, found economy-wide impacts, but they did not isolate the food price inflation effects. Qualitative studies like Adeniran (2016) outlined conceptual links between fuel and food prices but lacked empirical estimates of the inflationary impact. Shemilt et al. (2015) however, highlighted gaps in reliable quantitative evidence on the fuel subsidy-food inflation relationship that needs further empirical research within the Nigerian context. More so, when the issue of subsidy removal has generated so much heat that created negative ripples across the socio-political and economic space in Nigeria, and threatens food security of the nation among others.

Consequently, this study aims to fill the knowledge gap by empirically estimating the impact of fuel subsidy payments on domestic food price inflation over 2015-2022. The results can inform evidence-based policy decisions around managing fuel subsidies in a welfare-enhancing manner. The analysis is timely as Nigeria debates options on subsidy reform, while recovering from global energy and food price shocks.

2. Literature Review

2.1 Conceptual Clarification

2.1.1 Fuel Subsidy

According to Hlasny (2011) Fuel subsidy has been described as act of making fuel cheaper for consumers by government bearing part of the cost of production, transportation, and marketing (Hlasny, 2011) . Similarly, Birol (1995) noted that subsidy is an indirect tax in which government funds the difference between the markets determined prices of commodities and what government thinks should be the price paid by consumers. Additionally, Kojima (2015) sees fuel subsidies as measures that keep prices for consumers below market levels for example by reducing the price of petroleum products, heating oil, electricity or biofuels through grants/tax exemptions. The definition by Kojima (2015) is adopted as the working definition of fuel subsidy because it is the most comprehensive as it captures various forms through which fuel subsidies can be provided beyond just direct price reductions, like tax exemptions and grants. It also covers different fuel types including petroleum, heating oil, electricity and biofuels. The broader scope makes it a more complete definition.

2.1.2 Food Inflation

Bhattacharya, Jain and Singh. (2019) refer to food inflation as the increase in prices of food products over time. It indicates the increasing cost of food production, packaging, transportation, demand-supply gaps, and other macroeconomic factors. Likewise, Kamgnia (2011) defined food inflation as the rate of increase in the price of a fixed basket of food products purchased by consumers. It is influenced by rising input costs of agriculture, including seeds, fertilizers, animal feed, labor, as well as food processing, storage, transportation and retailing costs. On the other hand, Bandara (2013) defined food inflation as the persistent increase in the general price level of food commodities over a period of time. It reduces consumer purchasing power and indicates rising food production and distribution costs due to factors like weather disruptions, higher energy prices, supply chain issues, and growing global food demand. This study adopts the definition by Bandara (2013) as its working definition. This is premised on the fact that Bandara's definition is the most inclusive, and accurately captures the key aspects of food inflation. It emphasizes that food inflation refers to a sustained general increase in food prices over time. The definition rightly points out the impacts of inflation, such as reduced consumer purchasing power. It also identifies the major contributing factors to food inflation, like production costs, climate events, energy prices, supply chain disruptions, and demand-supply imbalances in global food markets. Overall, this definition covers the essential characteristics and implications of food inflation in a clear and concise manner.

2.2 Theoretical Literature

2.2.1 Price Transmission Theory

Price Transmission Theory emerged in agricultural economics literature in the 1920s-30s through pioneering work by economists like Henry Schultz who examined how commodity price changes propagate through supply chains (Schultz, 1938). The theory analyzes vertical price linkages and how a price change for an input commodity or at one stage of the supply chain transmits to prices at other stages, ultimately impacting the final consumer price.

The theory looks at how changes in input prices transmit through the supply chain and get reflected in final consumer prices. It can explain the mechanism of how changes in fuel costs from subsidy removal impact farm production costs, transportation expenses and ultimately retail food prices. The key point is that prices are interconnected throughout the production and distribution process. For example, an increase in the price farmers receive for their crops can translate into higher wholesale and retail food prices (Vavra & Goodwin, 2005). The theory quantifies these price transmission elasticities. It has been applied extensively in energy, agriculture and food markets. Price Transmission Theory is relevant for this study as it provides an appropriate framework to model how changes in fuel costs from altering subsidy levels can affect downstream prices of agricultural outputs and food products. Removing fuel subsidies raises input costs to farmers, processors, and transporters. By estimating price transmission elasticities, the impact on consumer food inflation can be quantified (Abdulai, 2000). The theory has been used widely in related contexts to examine energy-agriculture price linkages. With time series data on fuel prices and food costs in Nigeria, it allows empirically estimating the magnitude of transmission effects from fuel subsidy changes to food inflation.

2.2.2 Food Price Inflation Theories

Theories explaining drivers of food price inflation emerged in the 1970s-80s as economists observed rising and volatile food prices globally. Early theories like the Food Price Spiral model were conceptualized by economists such as Williams and Wright (1991). This theory posits that multiple supply and demand factors interact to fuel self-reinforcing cycles of increasing food prices. A key aspect is the role of energy-related costs like fuel and fertilizers in agricultural production and food processing. Rising energy prices raise farm and transportation costs, resulting in higher food prices. In turn, this sparks wage demands to compensate for cost of living increases, further fueling inflationary pressures. Other determinants include climate shocks, export restrictions, speculation, depreciating currencies and rising incomes in developing countries. The interacting effects create inflation spirals. This provides a relevant framework for examining how changes in fuel subsidy payments could influence food production expenses and consumer price inflation (Minot, 2014). With time series data, food price inflation theories allow modeling dynamic relationships between energy costs, farm input prices, agricultural wages and food price inflation (Rapsomanikis & Sarris, 2008). This can shed light on the extent to which fuel subsidy changes transmit to domestic food prices in Nigeria. However, these theories have limitations in accounting for micro-level factors like market power and price rigidities that may dampen inflationary effects. Overall, food price inflation theories offer useful conceptual models to analyze the impact of fuel costs on food prices.

2.2.3 Multi-Market Models

Multi-market models emerged in consumer theory literature in the 1970s-80s, pioneered by economists like Angus Deaton, John Muellbauer, and Jerry Hausman. They developed models like the Linear Expenditure System (Stone, 1954) and the Almost Ideal Demand System - AIDS (Deaton & Muellbauer, 1980). The key idea is that consumer demand is interconnected across related markets or product groups. For instance, an increase in the price of fuel can shape spending on other travel-related goods. Or changes in income redistribute demand across different consumption categories. Multi-market models estimate these cross-price and expenditure elasticities.

For this study, multi-market models like the AIDS provide a framework to analyze consumer response across interconnected fuel and food markets. Removing fuel subsidies would raise fuel prices, potentially dampening household spending in food markets. Estimating cross-price elasticities can quantify this effect and complement sector-specific analyses (Cornelsen et al., 2015). However, limitations are that these models rely on assumptions like weak separability and static expectations. They may also underestimate rigidity in consumer response. Overall, multi-market models can offer useful insights into demand interactions between fuel and food expenditure as subsidies change.

2.2.4 Optimal Policy Theory

Optimal policy theory has its origins in welfare economics advanced by A.C. Pigou, Frank Ramsey and Arthur

Cecil Pigou in the 1920s. It formally models the role of government interventions to correct market failures and maximize social welfare (Ramsey, 1927). The main premise is that unfettered markets can lead to sub-optimal outcomes due to externalities, public goods, imperfect competition or information failures.

An optimal policy framework analyzes government tools like taxes, subsidies, regulations or direct provision to improve efficiency and social welfare. For example, theoretical models can identify the optimal level of a production subsidy that maximizes net welfare gains for society. This offers a lens to examine fuel subsidy policy options. Given negative externalities and distributional goals, models can estimate the optimal fuel subsidy schedule for the Nigerian context that enhances social welfare beyond market equilibrium (Mayeres & Proost, 2001). However, information constraints, political economy factors, and model uncertainties pose challenges in applying optimal policy theory. Overall, it provides a useful normative approach complementing positive analysis when evaluating public policy towards fuel subsidies.

2.3 Empirical Literature

The study reviewed a number of empirical literature that are germane to our study. Ozili and Obiora (2023) analyzed the potential implications of removing gasoline and diesel fuel subsidies on key economic variables in Nigeria. Their research encompassed an examination of the channels through which the removal of subsidies could impact inflation, government revenue and spending, GDP growth, income distribution, and other outcomes within Nigeria. The methodology adopted for this study involved a comprehensive review of prior research and evidence concerning the effects of subsidy reform in Nigeria and other nations. It also included a theoretical discussion of the various macroeconomic mechanisms through which the elimination of fuel subsidies could influence the broader economy. The primary variables under investigation encompassed fuel prices, inflation, government fiscal accounts, GDP growth, poverty, and inequality. The study's findings indicated that the removal of fuel subsidies could result in substantial fiscal savings for the Nigerian government. However, the gradual phase-out of subsidies was recommended, accompanied by complementary policies to mitigate potential inflationary impacts and provide support to low-income populations vulnerable to rising prices. As for the major recommendations, the study advised the gradual phasing out of subsidies, the implementation of targeted cash transfers to citizens, and the strategic allocation of windfall oil revenue gains toward productivity-enhancing investments that stimulate inclusive growth.

In another study, Amaglobeli et al. (2023) made a significant contribution to empirical research by analyzing the macroeconomic and distributional consequences of energy and food price shocks and assessing policy response options. Their work built upon previous IMF research focused on inflation episodes and strategies for mitigating their impact. The primary goal was to evaluate the effects of the substantial commodity price spikes observed in 2021-2022 across more than 150 countries and offer valuable insights into effective policy responses. The research considered both macro-fiscal aspects and their impact on household welfare during this period. The methodology combined statistical analysis of inflation patterns with model simulations of various policy scenarios. Key variables under scrutiny encompassed energy and food prices, consumer inflation, fiscal costs, and the distribution of household income. The study's findings revealed that the energy and food price shocks had contributed to increased inflation and had a disproportionate negative impact on low-income households. Consequently, the study recommended the adoption of targeted, temporary measures that specifically address vulnerable groups as the most efficient policy response. In terms of specific recommendations, the research paper suggested the utilization of cash transfers, tax cuts, or subsidies targeted at poor households, while avoiding broad subsidies or price controls. Additionally, the study emphasized the importance of expediting the transition to clean energy as a means of enhancing resilience.

Besides, McCulloch et al. (2021) research also contributed to the empirical literature on energy subsidy reform and distributional impacts in developing countries. Their study aimed to quantify the distributional effects of potential fuel subsidy reform in Nigeria, focusing on both urban and rural households. The analysis centered on gasoline and diesel subsidies in Nigeria spanning the years 2016 to 2020. The research employed a methodology that combined energy-economic modeling using the Nigeria LEAP-ISEM model with micro simulation analysis of household survey data. These models estimated the effects of removing subsidies on consumer fuel prices and the subsequent changes in household expenditures. Key variables examined included fuel prices, household consumption patterns, sources of income, and demographic factors. The study's findings indicated that the removal of fuel subsidies would have a regressive impact, disproportionately affecting the poorest households. These impacts were more pronounced for urban households compared to rural ones. Nevertheless, the study suggested that targeted cash transfers from the government could help mitigate the adverse effects on lower-income groups. As a result, the study recommended a gradual phase-out of subsidies, the targeted allocation of cash transfers to lower income groups, and the enhancement of social safety nets to safeguard vulnerable populations during the transition period following subsidy removal.

In his own research, Omotosho (2019) delved into the macroeconomic consequences of oil price shocks and the existing fuel subsidy system in Nigeria. The study employed a New-Keynesian DSGE (Dynamic Stochastic

General Equilibrium) model, factoring in the pass-through effect of international oil prices on retail fuel prices. This model was tailored to data spanning from the second quarter of 2000 to the end of 2018, encompassing eleven key macroeconomic variables. These variables covered aspects such as the Consumer Price Index, nominal interest rates, exchange rates, real GDP per capita, consumption and investment per capita, international oil prices adjusted by foreign price indices, foreign real GDP per capita, foreign aggregate CPI, and foreign interest rates. The model's estimations were derived through Bayesian methodology. The study's outcomes unveiled that oil price shocks wielded substantial and enduring impacts on economic output, accounting for roughly 22 percent of variations over a four-year period. In the context of the benchmark model, which includes fuel subsidies, a negative oil price shock resulted in a contraction of the overall GDP, a boost in non-oil GDP, an increase in headline inflation, and depreciation of the exchange rate. However, the results from the model without fuel subsidies indicated that the contractionary effect of a negative oil price shock on the overall GDP was moderated, headline inflation decreased, and the exchange rate underwent more significant depreciation in the short term. Additionally, counterfactual simulations demonstrated that the removal of fuel subsidies led to heightened macroeconomic instability and had notable implications for the response of monetary policy to an oil price shock. Consequently, the study emphasized the necessity for a well-targeted safety net and sustainable adjustment mechanisms in any successful fuel subsidy reform.

Elsewhere in a study, Harun et al. (2018) conducted an analysis of the repercussions of the fuel subsidy removal policy on input costs within various production sectors in Malaysia. They employed the Input-Output Price Model and utilized the Malaysia Input-Output Table from 2010 for their study. The removal of subsidies on fuels like RON95, RON97, and Diesel resulted in an average fuel price increase of 32%. This price hike, in turn, translated into increased input costs for production across all 66 sectors studied. Notably, the rise in input costs for each sector surpassed the escalation in fuel prices. Four sectors, namely fishing and aquaculture, transportation and storage, utilities, and crops, animal production, and hunting, as well as food products, experienced input costs higher than the impact of the fuel subsidy removal policy. It's worth highlighting that the application of the Input-Output Price Model is relatively infrequent in prior research in Malaysia, despite its suitability for assessing the impact of fuel subsidy removal on sector-specific input costs. This study underscores the substantial influence of eliminating fuel subsidies on inflation in the country and the potential challenges posed by volatile global oil prices to Malaysia's economic stability.

Furthermore, in a sectoral study, Akinyemi et al. (2017) conducted an analysis of how the agricultural sector in Nigeria responded to the removal of the subsidy on refined petroleum, recognizing its pivotal role in the country. They employed a dynamic energy-environment CGE (Computable General Equilibrium) model based on the 2006 Nigerian Social Accounting Matrix (SAM) to carry out this study. The research presented results based on three distinct simulation scenarios: a partial (50 per cent) removal, a gradual removal, and a one-time complete removal of the subsidy on imported refined oil in Nigeria. The study's findings demonstrated that a complete or one-time removal of the fuel subsidy yielded more favorable outcomes, as many key macroeconomic variables exhibited improvement under the complete removal simulation scenario. As a recommendation, the study proposed that a one-time removal of the fuel subsidy could bolster the performance and output of the agricultural sector, even though it might lead to short-term price increases. Over the long term, dedicating funds to infrastructure and technological development is anticipated to support overall growth and enhance food security in Nigeria.

In another Nigerian-based study, Adeniran (2016), carried out a qualitative content analysis study to investigate the impact of fuel subsidy on transport costs and transport rates. The study revealed a complex web of consequences resulting from the removal of fuel subsidies. The findings were as follows: the removal of fuel subsidies had multiple effects on transport costs, transport rates, and production costs. The cost of procurement increased, affecting various sectors. Households became more cautious with their spending to compensate for the extra expenses on fuel. Unnecessary trips were canceled due to the rise in transportation costs, and there was a reduction in motorization as people sought alternatives to cope with higher fuel costs. Moreover, fuel subsidy removal encouraged more responsible fuel consumption, resulting in reduced carbon emissions. In a developing country like Nigeria, fuel subsidy played a crucial role in enhancing the welfare of citizens, especially low- and middle-income earners. However, the study stressed the need for stringent monitoring of fuel subsidy disbursement to prevent corruption, as past administrations had faced corruption issues in this regard. The study recommended the implementation of strict policies as penalties for any corrupt political office holder. Furthermore, it underscored the importance of meeting seven specific recommendations before considering fuel subsidy removal.

Some other study that made a valuable contribution to the empirical literature includes the work of Adeoti et al. (2016) probed into fossil fuel subsidies and reform options within the Nigerian context, built upon prior research that delved into the fiscal, economic, and household effects of fuel subsidies in Nigeria. The study's primary objective was to offer a comprehensive analysis of the evolution of Nigeria's fuel subsidy program, examining its fiscal costs and benefits, and providing policy considerations for reform. The research encompassed gasoline and diesel subsidies in Nigeria from the 1970s to 2015. The methodology involved an extensive review of existing literature, government data, and stakeholder perspectives to characterize and assess the fuel subsidy regime. Key variables under scrutiny included subsidy payments, fuel prices, consumption patterns, government expenditures, and the country's dependence on oil revenue. The study's findings indicated that fuel subsidies had become fiscally unsustainable for the Nigerian government. Nonetheless, the removal of these subsidies needed to be approached carefully, considering the impact on citizens' welfare, by enhancing the targeting of benefits and the implementation of social assistance programs. Consequently, the study recommended a gradual phase-out of subsidies, the reinvestment of savings into pro-poor social programs, the utilization of targeted cash transfers, and the adoption of price smoothing mechanisms during the transition period.

A critical analysis of the methodology used in simulation modeling studies that aims to inform policy decisions on food pricing interventions was provided by Shemilt et al. (2015). The primary goal of the study was to assess the suitability of evidence from the existing body of research on food taxes and subsidies for practical policy guidance. Their research scope encompassed modeling studies published over the past 15 years that simulated the potential impact of food taxes and subsidies on consumption patterns, health outcomes, and other related variables. The methodology involved a systematic review to identify and evaluate the methodologies used in these modeling studies. Key variables examined within these models included food demand elasticities, cross-price elasticities, consumption effects, and health impacts. The study's conclusions highlighted significant limitations in the existing modeling studies, specifically in their capacity to provide reliable guidance for policymaking. These limitations stemmed from uncertainties in model structure and parameter estimates. Consequently, the study's major recommendations called for enhanced transparency and more rigorous testing of published models before their findings were used as a basis for policy decisions related to food pricing interventions. The paper critically scrutinized the methodology employed in food tax and subsidy modeling studies, shedding light on issues concerning model validation and uncertainty analysis. It emphasized the current constraints that limit the ability of these simulation models to offer robust evidence directly applicable to real-world policymaking in this domain. The study underscored the need for caution in relying on these models for policy guidance.

Another study conducted examine the impact of fuel subsidy removal on the prices of selected food items in Port Harcourt, Rivers State, Nigeria was carried out by (Ekine & Okidim, 2013). The food items under consideration included rice, yam, garri, beef, and fish. The study's primary objectives were to assess how the removal of fuel subsidies affected the prices of these food items, both before and after the subsidy removal, and to investigate whether subsidy removal contributed to inflation. The researchers relied on secondary data for their analysis and constructed five separate regression models. In these models, fuel subsidy served as the independent variable, while rice, yam, beef, garri, and fish were the dependent variables. The study found that: notably, between 1966 and 2012, Nigeria had removed subsidies on 24 occasions in a span of 50 years. During this time, it was observed that the prices of several food items, especially beef and fish, experienced significant increases, particularly in the years following fuel subsidy removal, with a notable surge between 2001 and 2012. In conclusion, the study found that the removal of fuel subsidy had a discernible impact on food prices. As a way of recommendation, the study suggested that the policy of fuel subsidy removal should be implemented gradually to mitigate further increases in the prices of essential food items in Nigeria.

The existing literature on fuel subsidies in Nigeria has not adequately captured the specific impact of fuel subsidy payments on food price inflation nationally. For instance, studies like Ozili and Obiora (2023) provided a broad analysis of the macroeconomic implications of removing fuel subsidies, but did not empirically examine the downstream effects on food inflation. While McCulloch et al. (2021) focused on distributional impacts of subsidy removal across households, thus, their study did not quantify the inflationary effects on domestic food prices. Models such as that employed in Omotosho (2019) incorporated fuel prices but did not explicitly analyze the pass-through to food inflation under different subsidy scenarios. Sectoral analyses like Harun et al. (2018) examined the impacts of subsidy removal on production costs, but only for non-agricultural sectors, without looking at agriculture and food industries. Akinyemi et al. (2017) found economy-wide impacts but did not isolate the food price inflation effects. Qualitative studies like Adeniran (2016) outlined conceptual linkages between fuel and food prices but lacked empirical estimates of the inflationary impact. Shemilt et al. (2015) highlighted limitations in existing food subsidy modeling studies, pointing to gaps in reliable quantitative evidence on the fuel subsidy-food inflation nexus that needs to be addressed within the Nigerian context through further empirical research. As a corollary to the aforementioned, our study intends to bring these identified gaps in the reviewed works.

3. Methodology

3.1. Theoretical Framework

Price Transmission Theory provides the most appropriate theoretical framework to analyze the impact of fuel subsidy payments on food inflation in Nigeria. Price Transmission Theory elucidates how changes in input costs like fuel prices transmit through the supply chain to shape final output prices like food (Vavra & Goodwin, 2005). The theory is based on the concept that vertical price linkages connect the different stages of production and distribution.

In this study context, the theory models how altering fuel subsidy levels influences fuel costs facing farmers, food processors and distributors in Nigeria. Specifically, reducing fuel subsidies raises the pump prices of gasoline, diesel and other fuels used in agricultural machinery, transportation vehicles, storage facilities etc. Higher fuel costs raise business expenses for agricultural producers, food companies, transporters and retailers. To maintain margins, these cost increases get passed on through the supply chain, ultimately resulting in higher consumer prices for food items. Through estimating the price transmission elasticities at each stage, the magnitude of pass-through from fuel subsidy changes to retail food inflation can be quantified. Factors like market structure, competitive dynamics, regulations, inventory adjustment and substitutability impact the transmission effects across the supply chain (Meyer & von Cramon-Taubadel, 2004). Overall, Price Transmission Theory captures the sequential process linking fuel subsidy payments to fuel costs, production and distribution expenses, and ultimately retail food prices. By empirically modeling these structural relationships, the theory provides a robust framework aligned with the study objective.

3.2 Model Specification

While there are limited previous studies examining the relationship between fuel subsidy payments and food inflation specifically in Nigeria, this research adapted aspects of the model specification used in Ekine and Okidim (2013). Their study analyzed the impact of fuel subsidy removal on prices of certain food items like rice, yam, beef, garri and fish in Nigeria. However, unlike Ekine and Okidim's approach, the model in this study contains a more parsimonious set of variables tailored to the specific research objective on fuel subsidies and nationwide food inflation. In particular, the model focuses on key determinants of food inflation including fuel subsidy payments, international crude oil prices, agricultural productivity, and per capita income. This streamlined variables selection is theoretically justified and appropriate for addressing the aim of estimating fuel subsidies' effect on overall domestic food prices. The model specifies food inflation as a function of these explanatory variables in a focused manner. The functional, mathematical and baseline econometric models are presented in equations 3.1 3.2 and 3.3 respectively. By concentrating on the core factors elucidating the relationship between subsidies and food inflation, the model provides targeted insights on the relationship for policy analysis while maintaining adequate explanatory power. The functional, mathematical and econometric models are presented below in equations 3.1, 3.2 and 3.3 respectively.

$$FINF_t = f(FSUB_t, OILP_t, AGP_t, PCI_t) \quad 3.1$$

$$FINF_t = \alpha_0 + \alpha_1 FSUB_t + \alpha_2 OILP_t + \alpha_3 AGP_t + \alpha_4 PCI_t \quad 3.2$$

$$FINF_t = \alpha_0 + \alpha_1 FSUB_t + \alpha_2 OILP_t + \alpha_3 AGP_t + \alpha_4 PCI_t + \varepsilon_t \quad 3.3$$

where, α_0 is the intercept; α_1- α_4 are the coefficients of the variables; ε_t represents the stochastic error term; $FINF_t$ represents current food inflation, $FSUB_t$ stands for current fuel subsidy payments, $OILP_t$ is current international crude oil prices, $AGPt$ stands for current agricultural productivity, while PCI_t represents current per capita income. *A priori* Expectation- $OILP_t$, $PCI_t > 0$; $FSUB_t$, $AGP_t < 0$. Fuel subsidy payments and agricultural productivity are expected to have a dampening impact on food inflation, while crude oil prices and income levels would have an inflationary effect, based on standard demand-supply mechanisms and cost transmission theories. The relative magnitudes of the coefficients will be estimated in the empirical model.

3.3 Method of Data Analysis

The study utilized Autoregressive Distributed Lag (ARDL) modeling to conduct the empirical analysis examining the relationship between fuel subsidy payments and food inflation in Nigeria. ARDL, also known as the bounds testing approach, has emerged as a popular time series modeling technique in recent research for assessing connections between economic variables (Pesaran et al., 2001). One key advantage of ARDL models is their flexibility in terms of estimating relationships regardless of whether the time series are stationary I(0), non-stationary I(1) or mutually cointegrated (Sam et al., 2019). This overcomes issues with pre-testing for unit roots and cointegration associated with conventional modeling procedures. Additionally, a beneficial feature of the ARDL framework is its ability to simultaneously model the variables in levels and first differences, providing both long-run equilibrium and short-run dynamic impact estimates within a unified structure (Mcnown, 2018). For the objectives of this study on fuel subsidies and food inflation in Nigeria, the ARDL approach is well-suited for several reasons. First, the time series variables in the model likely demonstrate a combination of I(0) and I(1) characteristics fitting the ARDL structure. Second, the use of quarterly data over a period of time makes ARDL appropriate for assessing any cointegrating relationships. Third, the technique's capacity to concurrently estimate short and long-run effects yields useful insights for food subsidy policy analysis and reform considerations.

3.4 Types and Sources of Data

The study used secondary data. In particular, the study used quarterly time series data spanning 2015:Q1-2022:Q. The data for food inflation, and agricultural productivity were sourced from the Central Bank of Nigeria [CBN] (2023), fuel subsidy payments was gotten from PricewaterhouseCoopers [PwC] (2023), crude oil price was gotten from OilPrice.com (2023), while the data for per capita income was sourced from the World Bank (2023) database. Due to the non-availability of quarterly data for the variables of fuel subsidy payments and per capita income, the series were interpolated to derive quarterly data from the available annual data. The study used the numerical methods using Eviews to generate quarterly series for this study.

3.5 Estimation Procedure

3.5.1 Descriptive statistics

The study carried out a detailed descriptive statistical analysis of the dataset covering key parameters including the mean, minimum and maximum values, standard deviation, skewness, kurtosis, and the Jarque-Bera test. This descriptive analysis provides useful insights into the historical characteristics and distributional properties of the data on food inflation, fuel subsidies, crude oil prices, agricultural productivity and income in Nigeria.

3.5.2 Unit Root Test

The study utilized two standard unit root tests - the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test, to examine the time series properties of the data and check for stationarity. The ADF test, developed by Dickey and Fuller (1979), is a commonly applied statistical procedure for testing the null hypothesis that a time series contains a unit root against the alternative that it is stationary. It achieves this by estimating a model with lagged values of the differenced variable and checking whether the coefficient on the trend term differs significantly from zero. Along with the ADF test, the Phillips-Perron (PP) unit root test, proposed by Phillips and Perron (1988), was also used to assess stationarity. While similar to the ADF test in its null and alternative hypotheses, the PP test employs a non-parametric correction to account for any serial correlation and heteroscedasticity in the errors rather than including lagged differences. Given their widespread use and reputation as standard unit root tests, the ADF and PP tests were applied in this study to rigorously check the order of integration of the time series data on food inflation, fuel subsidies, crude oil prices, agricultural productivity and income. Determining the stationarity properties helped ensure methodological robustness before proceeding with the ARDL model estimation and analysis.

3.5.3 The ARDL Approach to Co-integration

The ARDL modeling approach involves several key steps which were followed systematically in this study: first, after conducting unit root tests to examine stationarity, the bounds testing procedure of Pesaran et al. (2001) was applied to assess the presence of a long-run cointegrating relationship among the variables. Second, based on establishing cointegration, the next stage estimated the long-run equilibrium relationship along with short-run dynamics using the ARDL error correction specification. Third, the fitted model was used to generate estimates of both the long-run multiplier coefficients and the short-run impact coefficients relating the explanatory factors to food inflation. Finally, model stability and parameter constancy were evaluated using the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) tests proposed by Brown et al. (1975). The ARDL model is written as:

$$Y_t = \alpha_0 + \varphi_t Y_{t-1} + \beta_t X_{t-1} + \varepsilon_t \qquad 3.4$$

where, Y_{t-1} and X_{t-1} are time series variables, ε_t is the vector of the stochastic error term. Generally, the model can also be defined as ARDL (p, q) the p and q are lag of the parameter which forms Equation 3.4:

$$y_t = \alpha_0 + \sum_{i=0}^{p} \varphi_i y_{t-1} + \sum_{j=0}^{q} \beta_j x_{t-1} + \varepsilon_t \qquad 3.5$$

Considering the explanation provided above, the ARDL model utilized in this study is formulated as:

$$\Delta FINF_t = \alpha_0 + \sum_{t=0}^{p} \varphi_1 \Delta FINF_{t-1} + \sum_{t=0}^{p} \varphi_2 \Delta FSUB_{t-1} + \sum_{t=0}^{p} \varphi_3 \Delta OILP_{t-1} + \sum_{t=0}^{p} \varphi_4 \Delta AGP_{t-1} + \sum_{t=0}^{p} \varphi_5 \Delta PCI_{t-1} + \alpha_1 \Delta FINF_{t-1} + \alpha_2 \Delta FSUB_{t-1} + \alpha_3 \Delta OILP_{t-1} + \alpha_4 \Delta AGP_{t-1} + \alpha_5 \Delta PCI_{t-1} + \varepsilon_t \qquad 3.6$$

where, α_0 is the intercept; α_1 *to* α_5 are the long-run multipliers; φ_1 *to* φ_5 represents the short-run dynamic coefficients of the model; *t* is the time dimension while; Δ is the difference operator, and ε_t is the error term. The long-run co-integration is estimated as:

$$\Delta FINF_t = \alpha_0 + \sum_{t=0}^{p} \varphi_1 \Delta FINF_{t-1} + \sum_{t=0}^{p} \varphi_2 \Delta FSUB_{t-1} + \sum_{t=0}^{p} \varphi_3 \Delta OILP_{t-1} + \sum_{t=0}^{p} \varphi_4 \Delta AGP_{t-1} + \sum_{t=0}^{p} \varphi_5 \Delta PCI_{t-1} \varepsilon_t \qquad 3.7$$

The determination of the ARDL maximum lag (p q) is made using the automatic lag length selection in E-Views. The study obtained the short-run dynamic parameter from the Error Correction Model (ECM) estimation, which is linked to the long-run estimate, as presented below:

$$\Delta FINF_t = \alpha_0 + \sum_{t=0}^{p} \varphi_1 \Delta FINF_{t-1} + \sum_{t=0}^{p} \varphi_2 \Delta FSUB_{t-1} + \sum_{t=0}^{p} \varphi_3 \Delta OILP_{t-1} + \sum_{t=0}^{p} \varphi_4 \Delta AGP_{t-1} + \sum_{t=0}^{p} \varphi_5 \Delta PCI_{t-1} + \theta ECM_{t-1} + \varepsilon_t \qquad 3.8 \qquad 3.8$$

In Equation *3.8* φ_1 to φ_5 are short-run dynamic coefficients converging to long-run equilibrium, while ECT_{t-1} is the speed of adjustment parameter and error correction model originating from the estimated equilibrium relationship.

3.5.4 Bound Test

The Bound test utilizes the least squares method to investigate the presence of a long-run relationship within the

ARDL equation. It employs an F-statistics test to evaluate the combined significance of the coefficient of lagged variables, $H_0: \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = \varphi_5 = 0$ against the alternative, $H_0: \varphi_1 \neq \varphi_2 \neq \varphi_3 \neq \varphi_4 \neq \varphi_5 \neq 0$. If the computed F-statistic exceeds the upper critical value, the null hypothesis is rejected. Conversely, if it falls below the lower critical value, the null hypothesis cannot be rejected, indicating the absence of a long-run relationship. When the F-statistic falls within the bounds, the result remains inconclusive.

3.5.5. Residual Diagnostic Tests

To confirm the reliability of the ARDL model findings, diagnostic tests were conducted including the Breusch-Godfrey serial correlation LM test to detect autocorrelation in the residuals, and the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests to check the stability of the estimated model's parameters over the sample period.

4. Results and Discussion of Findings

4.1 Descriptive Statistics

The descriptive statistics results are shown in Table 4.1. The descriptive statistics provided important insights into the historical behaviour of the data. The mean food inflation of 327 combined with the maximum of 590 indicates that overall, food inflation exhibited an upward trend over the period under review, with certain quarters witnessing very sharp spikes. The high standard deviation of 120 reflects considerable volatility and fluctuations in food inflation across quarters, pointing towards unpredictable large swings over time. The positively skewed distribution corroborates the presence of more extreme inflation spikes rather than a balanced variation around the mean, revealing that supply-side shocks disproportionately drove up food inflation at times. The leptokurtic distribution with a kurtosis value greater than 3 further highlights the presence of larger outliers, signifying that unexpected developments dramatically impacted food inflation in some periods.

Table 4.1: ***Descriptive Statistics Result***

	FINF	*FSUB*	*OILP*	*AGP*	*PCI*
Mean	327.0438	1.18E+12	60.71875	4419.358	689164.8
Median	300.1700	7.78E+11	60.50000	4249.340	686082.5
Maximum	590.2400	6.07E+12	108.0000	5625.360	967365.5
Minimum	172.8400	3.81E+09	30.00000	3176.600	509921.9
Std. Dev.	120.9240	1.39E+12	17.76774	821.0777	135297.9
Skewness	0.608133	2.214499	0.673003	0.091542	0.406896
Kurtosis	2.316261	7.384327	3.357610	1.439231	2.118745
Jarque-Bera	2.595733	51.78447	2.586156	3.292693	1.918492
Probability	0.273114	0.000000	0.274425	0.192753	0.383182
Observations	32	32	32	32	32

Source: ***Author's computation using E-views.***

Similarly, the astronomical mean fuel subsidy payment of 1.18 trillion naira reveals massive fiscal costs of subsidies on average, representing a huge burden for the government budget. The maximum payment of 6.07 trillion naira further highlights the unsustainable heights subsidy expenditures reached. The high standard deviation corresponds to volatile subsidy payments fluctuating with global oil prices, indicating amplified exposure to external shocks. Positive skewness shows frequent sharp increases beyond the average driven by oil price spikes, reflecting the asymmetric impacts of oil market developments. The crude oil price statistics also demonstrate comparable volatility, with a high standard deviation, positive skew indicating larger price increases than declines, and a leptokurtic non-normal distribution punctuated by extreme price spikes. In contrast, agricultural productivity and per capita income showed relatively stable trends over the period. Overall, the descriptive analysis strongly contextualizes the core issues of rising and unpredictable food inflation along with unsustainably high and volatile fuel subsidy expenditures over the 2015-2022 period, providing a useful foundation for the econometric analysis.

4.2 Unit Root Test

The study conducted the Unit root test using the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests, and the results are presented in Table 4.2.

Table 4.2: ***ADF & PP Unit Root Test Results***

Variable	ADF Stat.	Order of Integration	PP Stat.	Order of Integration
FINF	-4.379109 (-3.574244)	1(1)	8.733305 (-3.562882)	1(0)
FSUB	-5.729311 (-3.568379)	1(1)	-6.944817 (-3.568379)	1(1)
OILP	-4.364224 (-3.612199)	1(0)	-4.237279 (-3.568379)	1(1)
AGP	-24.02579 (-3.580623)	1(1)	-6.546122 (-3.562882)	1(0)
PCI	-4.832490 (-3.568379)	1(1)	-4.972206 (-3.568379)	1(1)

NB: Figures in parenthesis represents the critical values at the 5% level
Source: ***Author's computation using E-views.***

The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests applied to the variables are presented in Table 4.2. The tests were conducted at both the levels and first differences of the data series. The critical values for rejecting the null hypothesis of a unit root at the 5% significance level are shown in parentheses. As per the testing procedure, a variable is considered stationary if its calculated test statistic exceeds the critical value. The ADF test indicated non-stationarity at levels for all the variables except *OILP*, which was found stationary in levels itself. However, taking first differences made the data stationary for the other variables. On the other hand, the PP test results differed slightly, with *FINF* and *AGP* found stationary at levels, while others were stationary at first difference. The differing results between the ADF and PP tests imply a mix of I(0) and I(1) variables. This aligns well with the features of the dataset and supports the use of ARDL modelling which does not require pre-testing for unit roots. The stationarity testing provides methodological rigor and the basis for proceeding with the bounds testing and estimation of the ARDL error correction model in line with the study objectives.

4.3. ARDL Bounds Test

The study initiated the ARDL estimation by conducting the Bound test and determined the ARDL optimal model to be (4, 4, 4, 4, 2). Table 4.3 displays the results of the ARDL bounds test. The result of the Bound test indicated that the F-statistics value of 5.27 exceeds the upper bound critical values (I(1)) at all levels of significance. This implies the presence of a long-run relationship in the model. Consequently, the study proceeded to perform both the short-run and long-run versions of the ARDL model.

Table 4.3: ARDL Bound Test Result

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.273000	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: ***Author's Computation using E-views.***

4.4 ARDL Short-run Estimation

The ARDL short-run model, which is provided in Table 4.4, was estimated to validate the short-run dynamics and interactions of the parameters within the model.

Table 4.4: ***ARDL Short-Run Coefficient Estimates***
Dependent Variable: ***D(FINF)***

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FSUB)	-2.95E-12	1.56E-12	-1.885003	0.1181
D(FSUB(-1))	-4.53E-11	6.75E-12	-6.710787	0.0011
D(FSUB(-2))	-5.10E-11	6.35E-12	-8.027767	0.0005
D(FSUB(-3))	-4.99E-11	6.25E-12	-7.985556	0.0005
D(OILP)	0.428391	0.068007	6.299231	0.0015
D(OILP(-1))	1.012357	0.129978	7.788649	0.0006
D(OILP(-2))	0.864742	0.093685	9.230283	0.0003
D(OILP(-3))	0.464445	0.070557	6.582598	0.0012
D(AGP)	-0.067358	0.008704	-7.738899	0.0006
D(AGP(-1))	-0.335061	0.042591	-7.866895	0.0005
D(AGP(-2))	-0.252957	0.030495	-8.295166	0.0004
D(AGP(-3))	-0.152250	0.020071	-7.585624	0.0006
D(PCI)	-0.001471	0.000222	-6.634925	0.0012
D(PCI(-1))	0.000336	8.77E-05	3.832769	0.0122
*CointEq(-1)**	-2.737898	0.344190	7.954621	0.0005
R-squared	0.988886			
Adjusted R-squared	0.969993			

Source: ***Author's Computation using E-views.***

The ARDL short-run coefficient estimates provide several insights into the immediate dynamic impacts on food inflation. Fuel subsidy payments have a statistically significant negative effect on food inflation across the first three lagged periods. This indicates that reducing subsidies transmits quickly into higher domestic food prices within a quarter itself and this effect persists over subsequent quarters as well. Crude oil prices demonstrate a positive short-run relationship, wherein oil price hikes feed into food inflation with a lag of 1-3 quarters. Higher agricultural productivity lowers food inflation in the short run, with this effect lasting across several lagged periods. The impact of income levels is mixed, with a negative contemporaneous effect, and a significant small positive coefficient at lag 1. The error correction term is significant with the expected negative sign, confirming cointegration among the variables in the long run. The model demonstrates strong explanatory power as reflected in the adjusted R-squared of 0.97, aptly capturing the short-run dynamics. The ARDL short-run estimates align with economic intuition and theory. They highlight the immediate inflationary pressures that could arise if fuel subsidies are reduced without complementary mitigating policies to counteract the impact on citizens, at least in the shorter-term transition period.

Comparing the results of this study to the existing literature reviewed reveals some key similarities along with a few notable differences. The finding that reducing or removing fuel subsidies can transmit into higher food inflation aligns directionally with qualitative studies like Adeniran (2016) that conceptually outlined this linkage. Similarly, the short-run inflationary impact of lower subsidies is consistent with the expectations or hypotheses put forward in studies like Ozili & Obiora (2023) and McCulloch et al. (2021), although they did not empirically estimate the magnitude of this relationship. The positive effect of international crude oil prices on domestic food inflation also resonates with Amaglobeli et al. (2023) who found energy prices can amplify inflationary pressures. Additionally, the negative effect of agricultural productivity found here aligns with Akinyemi et al. (2017) that emphasized boosting agriculture to temper the price impacts of subsidy removal.

4.5 ARDL Long-run Estimation

The ARDL long-run model estimates are provided in Table 4.5

Table 4.5: ***ARDL Long-run Coefficient Estimates***
Dependent Variable: ***D(FINF)***

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FSUB	-1.17E-11	1.47E-12	-7.938046	0.0005
OILP	0.722775	0.045262	15.96887	0.0000
AGP	-0.136043	0.011364	-11.97179	0.0001
PCI	0.001078	2.49E-05	43.26104	0.0000
C	191.0355	33.49669	5.703115	0.0023

Source: ***Author's Computation using E-views.***

The ARDL long-run coefficient estimates provide evidence that fuel subsidy payments have a statistically significant negative association with food inflation in Nigeria over the long term, as seen by the coefficient of -1.17E-11 for the fuel subsidy variable (FSUB). This suggests that higher fuel subsidies are linked to lower food inflation in the country in the long run. In contrast, the model estimates show that global oil prices (OILP) have a highly significant positive coefficient of 0.722775, indicating that rising international oil prices lead to higher domestic food inflation in Nigeria over time, likely by increasing fuel-related production and transportation costs. Agricultural productivity (AGP) has a significant negative coefficient of -0.136043, implying that agricultural productivity reduce food inflation in the long run by providing incentives for higher productivity and food supplies. Per capita income (PCI) has a positive and statistically significant association with long-run food inflation, with a coefficient of 0.001078, potentially reflecting rising consumer demand and ability to pay that accompanies income growth. The results provide robust statistical evidence that fuel subsidies help lower food inflation in Nigeria in the long term, whereas oil prices and income levels raise food inflation over time.

The long-run ARDL model results exhibit both similarities and differences when compared and contrasted with the existing empirical literature. In terms of similarities, the model's negative coefficient on fuel subsidies is consistent with some studies indicating that the removal of fuel subsidies leads to higher food prices (Ekine & Okidim, 2013; Adeniran, 2016). Additionally, the model's positive oil price coefficient aligns with evidence from research that oil price hikes raise food production and transportation costs (McCulloch et al., 2021; Harun et al., 2018). The positive income coefficient also conforms to studies suggesting potential demand-side effects on food prices (Ozili & Obiora, 2023). Overall, the model lends support to literature pointing to the inflationary impacts of reducing or removing fuel subsidies, especially in relation to food prices (Amaglobeli et al., 2023). However, there are also notable differences between the model estimates and existing literature. The ARDL model isolates the specific effect of fuel subsidies on national food inflation, unlike broader macroeconomic analyses (Ozili & Obiora, 2023). It provides quantitative estimates of the fuel subsidy impact on food inflation, unlike conceptual studies (Adeniran, 2016). The model examines aggregate national food inflation, in contrast to sectoral analyses (Harun et al., 2018). It also empirically estimates the inflationary effects, unlike reviews that highlighted limitations in simulation models to accurately estimate such impacts (Shemilt et al., 2015). Additionally, the ARDL model distinguishes between short-run and long-run effects over time, unlike studies focused solely on short-term price changes (Ekine & Okidim, 2013). While the long-run results are mostly consistent with empirical literature identifying a linkage between fuel prices and food inflation, the ARDL model provides targeted quantitative estimates of the impact of national fuel subsidies on Nigeria's food inflation specifically, helping to address gaps in the existing literature.

4.6. Residual Diagnostic Test Results

The residuals for this study were tested for serial correlation and stability.

4.6.1 Breusch-Godfrey Serial Correlation LM Test Result

To test for serial correlation, the Breusch-Godfrey serial correlation LM test was employed, and the results are displayed in Table 4.6.

Table 4.6: ***Breusch-Godfrey Serial Correlation LM Test***

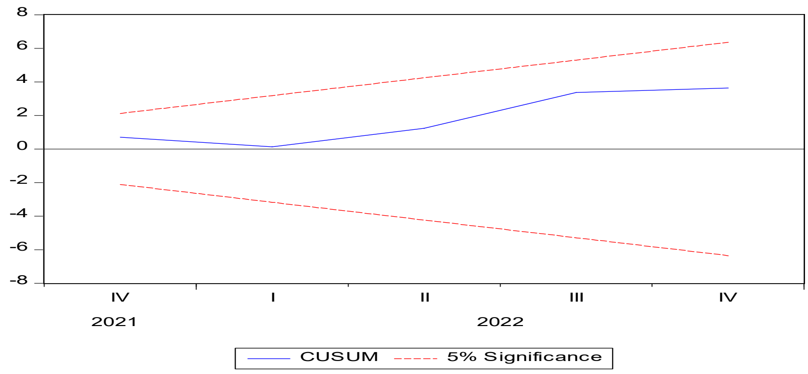
F-statistic	2.629769	Prob. F(2,3)	0.2189
Obs*R-squared	10.82994	Prob. Chi-Square(2)	0.1145

Source: ***Authors computation using E-views.***

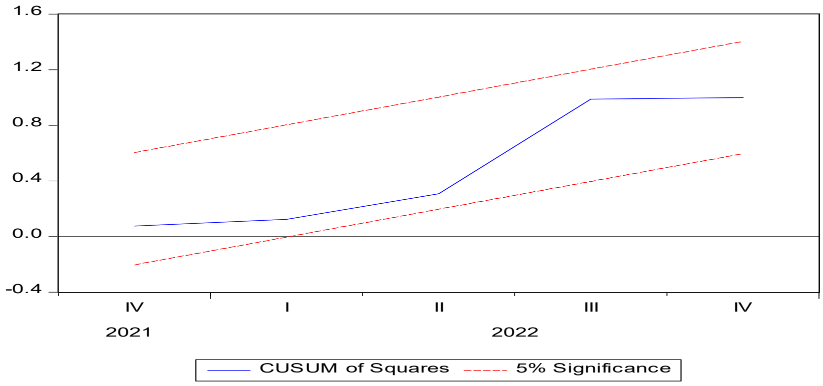
The result of the Breusch-Godfrey LM test supported the null hypothesis of no serial correlation in the residuals, as the probability associated with its F-statistics value of 0.22 exceeded the 5% significance level. This confirms that the ARDL model was not affected by the issue of serial autocorrelation.

4.6.2 CUSUM and CUSUMSQ Stability Test Results

The stability of the ARDL model was assessed using the CUSUM and CUSUMSQ tests, and the results are presented in Figures 4.1 and 4.2, respectively. These tests were applied to the residuals of the estimated model. An examination of the plots for the CUSUM and CUSUMSQ statistics in Figures 4.1 and 4.2 reveals that they all fall within the two straight lines, indicating the stability of the ARDL model.



Source: *Authors computation using E-view.*
Figure 4.1: *CUSUM Plot Result*



Source: *Authors computation using E-view.*
Figure 4.2: *CUSUMSQ Plot Result*

5. Recommendations and Conclusion

5. I Recommendations

Based on these conclusions, it is recommended that any reform of fuel subsidies in Nigeria should be gradual to mitigate short-run inflationary shocks and hardships for citizens. The fiscal gains from reducing subsidies could be partly channeled into targeted cash transfers for poor households to maintain the affordability of food. Investing the subsidy savings in raising agricultural productivity through infrastructure, R&D, extension services and related measures can also help dampen food inflationary pressures. Diversifying the economy's export base beyond oil is essential over the longer term to reduce exposure to volatile external oil prices. Monetary policy needs to remain vigilant regarding potential second-round inflationary effects stemming from fuel subsidy reform feeding into broader cost-push inflation dynamics. Ultimately, an integrated policy mix encompassing fiscal, monetary, structural, and social protection is imperative for the smooth and sustainable implementation of fuel subsidy reforms in a manner that safeguards citizens' welfare while attaining fiscal sustainability.

5.2 Conclusion

This study's provide robust empirical evidence that fuel subsidy payments have a statistically significant negative relationship with food inflation in Nigeria, both in the short-run and over the long term. The model estimates demonstrate that higher fuel subsidies are linked to lower national food inflation, while reducing subsidies quickly transmits into higher domestic food prices within a quarter itself. Furthermore, global crude oil prices positively impact Nigeria's food inflation over time by elevating production and transportation costs, underscoring the economy's vulnerability to external oil price shocks. Agricultural productivity is found to lower food inflation sustainably in the long run by providing incentives for greater agricultural output and availability. Additionally, the model results reveal that rising per capita incomes increase food inflation over the long term via higher consumer demand, highlighting the imperative of expanding domestic production capacity. Overall, the results align with the cost-push drivers of food inflation and confirm the substantial risks of inflationary shocks if fuel subsidies are removed without accompanying complementary policies.

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