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FROM STRUCTURAL ADJUSTMENT TO PETROLEUM DEREGULATION IN NIGERIA: ASYMMETRIC CONTROL ANALYSIS OF INFLATION AND WELFARE EFFECTS

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Abstract

This study investigates the structural macroeconomic consequences and causal policy implications of complete downstream petroleum sector deregulation in Nigeria, focusing specifically on the May 2023 fuel subsidy elimination. Rooted in Dependency and Social Contract theories, the research employs a rigorous tripartite econometric framework comprising a Non-Linear Autoregressive Distributed Lag (NARDL) model, a Time-Varying Parameter Structural Vector Autoregressions (TVP-SVAR) model, and a SCM counterfactual analysis using data spanning from 1986 through 2026. Zivot-Andrews and Gregory-Hansen tests endogenously confirm 1986 and 2023 as profound structural break dates within Nigeria's co-integration vector. The NARDL estimates reveal a stark long-run asymmetric price transmission mechanism, where positive fuel price shocks significantly accelerate headline inflation, whereas negative shocks exhibit severe downward price stickiness due to retail market frictions and transport inefficiencies. Simultaneously, currency devaluations rapidly pass through into domestic consumer prices, creating a self-reinforcing stagflationary loop with fuel import costs. Dynamically, the TVP-SVAR impulse responses demonstrate a sharp historical escalation in shock sensitivity, with the instantaneous pass-through coefficient surging from 0.154 in the 1986 SAP era to an unprecedented 0.584 in the post-2023 deregulated climate, confirming that the erosion of domestic refining infrastructure has structurally amplified the economy's vulnerability to cost-push energy shocks. To isolate clean policy causality, the SCM procedure constructs an uncorrupted counterfactual policy unshocked Nigeria from an optimized untreated comparison pool of 20 developing nations. The estimates reveal that by late 2024, the fuel subsidy removal

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exerted a statistically significant net causal treatment effect (τ) of +15.50 percentage points on headline inflation and a devastating +17.90 percentage points on the food poverty index. Placebo permutation checks validate that these structural gaps persist into 2026, marking a permanent contraction of household purchasing power rather than a transitory market adjustment. These findings indicate that conventional demand-side monetary tightening, such as interest rate hikes, is fundamentally ill-suited to combat an inflation profile driven by structural supply-side distortions. The study concludes that successful fiscal consolidation requires a phased approach, the restoration of domestic refining capacity, and institutionalized, pre-established transport and social safety nets to protect public welfare and preserve the domestic social contract.

Keywords: Structural Adjustment, Fuel Subsidy Removal, Downstream Deregulation, Nonlinear ARDL, TVP-SVAR, Synthetic Control Method, Price Asymmetry, Food Poverty Index, Nigeria.

JEL Classification: E31, Q43, C32, H23, I32.

1. INTRODUCTION

Nigeria's current macroeconomic predicaments can be attributed to the launch of the Structural Adjustment Program (SAP) in 1986 which marked the beginning of a sweeping macroeconomic policy programme of neo-liberal economic reforms (Dauda & Iwegbu, 2022). Over a number of years, Nigeria's domestic refinery capacity was neglected and eventually it was found that the country was completely dependent on importation of refined petroleum products (Ohalezim & Ngang, 2022). Successive governments institutionalized a large-scale system of petroleum subsidy in the downstream sector of the petroleum industry to protect the public from the fluctuations of exchange rate and the impact of international oil prices (Kere, 2018). This good intentions fiscal buffer eventually became an unsustainable burden and began to absorb a hefty percentage of national incomes leading to the allocation of disproportionately large resources to paying off this economic debt, which in turn appropriated funding needed for critical investments in social services, particularly in education (Olaniyi et al., 2023). The Nigerian government's sudden and complete deregulation of the downstream petroleum sector was undertaken in May 2023, facing growing fiscal deficits and impending debt crisis (Chukunalu et al., 2025). The policy shift climax of the structural adjustment decades met with great acclaim by the international financial institutions (IFIs) as a crucial measure towards long-term macroeconomic stabilization (Olaniyi et al., 2023).

The deregulation of the petroleum sector had some short-term implications which exposed the weaknesses of the Nigerian economy. Petrol prices in all the geopolitical zones in Nigeria rose drastically. According to Ajuwon and Abiodun (2026), energy cost is a major input variable in the transportation, manufacturing and logistics chains in Nigeria. Thus, the price rise of the fuel quickly filtered through the entire supply chain. Consequently, inflation has increased at a record level in the country, which recorded the headline figure above a shocking level of over 34% in mid-2024 (2024). The huge rise in general price levels witnessed a steep fall in real wages and brought about a serious cost of living crisis which disproportionately impacted the poor. According to Okonkwo & Ezenwegbu (2024), the household welfare impact was immense leading to a sharp decline in consumption of essential goods and basic nutrition by vulnerable households. Alongside this welfare calamity, the inflation transmission mechanism in Nigeria exhibits strong non-linear and asymmetrical characteristics (Sa'ad et al 2023).

Moreover, the floating of the national currency contributed to the situation at the same time and made it even worse because depreciation of the currency led to increases in the landing cost of imported fuel by the same amount, forming a vicious circle (2026). The government was expecting

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a short-term economic cost, but in fact the impact of the ensuing food poverty and macroeconomic instability has been much greater and longer lasting than initially projected by policy makers. Despite the various efforts at reforming the economy over the past decades ranging from SAP to the deregulation of target markets in the oil sector, Nigeria is still characterized by high inflation, unemployment, food insecurity and low real wages. As food prices continue to escalate and transportation costs to mount up, in response to the incentives offered in subsidy policies, more than 31 million Nigerians are reported to be entering acute food insecurity, thereby compromising the well-being of households and their socioeconomic vulnerability. This implies that the connection between petroleum price deregulation and welfare effects is yet to be fully understood, in the Nigerian context. The current literature has concentrated on the direct impacts of the petroleum sector deregulation on inflation, the fiscal balance or the overall level of economic growth, while neglecting to consider the asymmetric macroeconomic effects on welfare by the different sectors and social groups of society stemming from the upstream petroleum deregulation.

Perhaps more importantly, previous studies have focused on short-run adjustments to deregulation without taking into account the larger historical process of liberalization from SAP to current downstream petroleum market reforms. As a result, the empirical and theoretical literature lacks much on the evolution of asymmetric inflationary dynamics and welfare outcomes in Nigeria as a result of the cumulative impact of neoliberal reforms. Although there is an increasing literature addressing the subsidy removal of 2023, the vast majority of such analysis is based on linear models that do not adequately explain the time-varying, multi-faceted nature of this structural shock (Abdullahi et al., 2025). Robust counterfactuals are lacking and the continuous causal pathway between the 1986 structural adjustments and the petroleum deregulation in 2023 requires significant empirical work. Hence, the impetus of this study is a clear interest in measuring these macroeconomic impacts of deregulation in a precise empirical manner, with the view of giving a clear picture on the current inflationary condition of Nigeria and its effects on the welfare of the households, as the process of deregulation seems to have changed it forever.

Furthermore, the study will be beneficial to both Nigerian policy makers and the Nigerian government as it will give empirical data on the transmission of the deregulation policies in the economy and its impact on the inflation, production cost and the welfare of the household in the country. The study will prove a useful tool for policy makers when formulating more equitable and factually appropriate macro-economic policies to minimize the negative welfare effects of oil price shocks. Policymakers will gain insight into the asymmetric effects of deregulation on inflation and how that is driving conditions, which should help guide them in deciding on targeted stabilization measures to counteract increases in fuel prices without reacting to their corresponding declines.

The study will also help the monetary authorities, like the Central Bank of Nigeria, to enhance inflation-targeting framework and align monetary policies with fiscal policies to mitigate the impact of the petroleum price hikes on food prices, transportation and production costs. This study will analyze the dynamics of inflation and the channels through which it affects welfare, and provide fiscal authorities with the theoretical insight needed when designing compensatory social measures, social intervention programmes and substitute forms of subsidies for such a vulnerable group as households can withstand the process of deregulation without facing severe economic hardship. Further, findings are expected to offer empirical evidence on the sequencing and timing of reform implementation particularly in countries that suffer from structural rigidities, weak institutions and high investment in imports like Nigeria.

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The study will help the Nigerian government to gain better insight into the longer-term effects of policy change at the macroeconomic level (structural adjustment and deregulation in the downstream petroleum sector) on economic stability and poverty, unemployment and income inequality. The research will be used by the government to assess whether the potential gains from deregulation - sustained fiscal viability, investment, and less subsidy pressure - outweigh the price of inflation and loss of welfare paid by the citizens. This evidence will help government institutions develop more integrative and socially sensitive reform policies, which will be based on a trade-off between economic efficiency and welfare protection. This study will also assist the Government of the Republic to build resilience in its energy pricing policies, enhance palliative distribution network, create more resilient transportation and energy alternatives, etc., to mitigate the impact of fuel price fluctuations.

The research also benefits businesses and private sector operators by providing insights into how deregulation-induced inflation affects operating costs, supply chains, consumer purchasing power, and investment decisions. Businesses in manufacturing, transportation, agriculture, and retail sectors will gain a deeper understanding of the relationship between fuel price changes and production expenses, thereby enabling better cost forecasting, pricing strategies, and risk management. The findings will assist firms in developing adaptive business models capable of responding effectively to inflationary shocks arising from petroleum market liberalization. Furthermore, investors and corporate planners will benefit from improved knowledge of Nigeria's macroeconomic environment, which can support long-term investment planning and strategic decision-making. The study adds to academic and policy discourse by expanding existing literature on asymmetric macroeconomic effects of deregulation in developing economies. It will provide empirical evidence that may guide future reforms in other oil-dependent African economies facing similar challenges of subsidy removal, inflationary pressures, and welfare instability. Ultimately, the study will promote more informed, sustainable, and socially sensitive economic policymaking capable of fostering macroeconomic stability, inclusive growth, and improved welfare outcomes in Nigeria.

2. LITERATURE REVIEW

2.1 Theoretical Literature

The dependency theory states that developed, industrialized countries exploit (the core) developing, impoverished countries with plenty of resources (the periphery). The theory posits that peripheral areas end up in low value-added imports, high value exports trap, where they sell raw materials at low price but buy finished products at high price. Dependency theory provides the only macro-structural explanation of Nigeria's petroleum sector paradox in the framework of this study. Despite being one of the world's largest producers of crude oil and an exporter of the unrefined crude oil, Nigeria's failure to develop and sustain domestic refinery segments of her economy has placed it on the periphery (Ohalezim & Ngang, 2022). In 1986, the core international financial institutions designed the Structural Adjustment Programme to liberate the Nigerian economy but it did not offer the required domestic productive capacity to manage an open market (Nelson, 2025; Popoola, 2020). Consequently, Nigeria heavily depended on the world's core for refined petroleum products (Ohalezim & Ngang, 2022).

As per this theory, this multi-decade fuel subsidy was not simply a populist policy. Furthermore, it was a structural necessity that masked the economic loss that resulted from this asymmetrical exchange (Odubo & Odubo, 2025; Saka et al., 2023). The price instability in the market prompted the government to intervene by providing fuel subsidy. Ultimately the reason for the fuel subsidy

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was to protect the domestic markets from volatility and fluctuations in the international price of the fuel and constant depreciation of the exchange rate (Olujobi & Irumekhai, 2024). The final deregulation in May 2023 is the end point of this dependence (Chukunalu et al., 2025; Ikenga & Oluka, 2023). The state had to yield to the importation as the cost of refining petroleum from depreciating crude oil became too high (Ayoola, 2025; Ozili & Obiora, 2023). The framework models theoretically depicted with TVP-SVAR and NARDL are perfectly captured by Dependency Theory which explains why Nigerian macroeconomy is so vulnerable and asymmetric price sensitive to global energy cost shocks.

***Social Contract Theory- The Domestic Welfare Explanation*:** The study shifts its attention to Social Contract Theory, which comes from the classical thought of Thomas Hobbes, John Locke and Jean Jacques Rousseau, in order to gain a better understanding of domestic socio-economic impact of deregulation (Tamang, 2023). According to this theory, citizens confer legitimate power to the state which forms an implicit contract. Citizens give away some freedom and submit to regulations imposed by the state (e.g., pay tax, obey law etc.) in exchange for the state's protection of citizens' rights, security for economic interest and general public good (Kelsall et al., 2022). Within the Nigerian socio-political context, failure of the state to fulfil even the most basic welfare standard like uninterrupted power supply, adequate access to health care, comprehensive social security, etc. (Omilusi, 2018). Over the years, heavily subsidized retail petrol became the main social contract between the government and the people (Houeland, 2022). The availability of subsidized energy in Nigeria became the most easily measurable economic benefit of being a citizen of Nigeria. In its impact on fiscal policy, it suppressed the cost of transportation, food distribution and manufacturing, (Inegbedion et al, 2020).

The sudden fuel subsidy withdrawal by the Nigerian government in 2023 was therefore considered a unilateral breach of this social contract from the perspective of this theory. The state removed its primary welfare facilities but did not set up either alternative social safety nets or viable mass transport system (Olujobi & Irumekhai, 2024). The empirical findings obtained from the implementation of the Synthetic Control Method (SCM) are accurate due to this theoretical gap. The sharp increase in the headline inflation and the sudden sharp increase in the food poverty index (FPI) were not imaginary. Indeed, it was the citizenry who were forced to pay for this change in the terms of the social contract by the state (Akinrinde & Telukdarie, 2024; Ifeyinwa et al., 2025). In addition, the peculiar nature of the market to resist price reduc-tions is a consequence of the warped economic structure which burdens vulnerable households with the weight of structural economic adjustment on a permanent basis (Mohammed & Musa, 2026; Yahaya, 2026).

***Synthesis of the Theoretical Framework*:** The synthesis of Dependency Theory and Social Contract Theory forms a strong sequential explanation matrix for this research. The reason for the dependency theory is the reliance of the peripheral state on imported energy, which also paralyzed the fiscal power of the peripheral state and converted deregulation into an unavoidable macro-structural necessity. This is a phenomenon in social contract theory – when the unprotected execution of the policy battered domestic trust and left the people facing an unprecedented cost-of-living crisis. These theories support the main hypothesis of this study, in that deregulation, when properly carried out, can reflect the external imbalance pointed out by Dependency Theory; however, if the process of deregulation is not accompanied by the establishment of functional domestic infrastructure and safety nets, it renders the process incompatible with the Social Contract and advocates fiscal consolidation over human welfare.

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2.2 Empirical Findings

The impact of neoliberal structural adjustment policies on macroeconomic parameters such as inflation, welfare, and economic stability has been the subject of growing scholarly interest in the literature on structural adjustment policies and petroleum deregulation in Nigeria. The Structural Adjustment Programme (SAP) reforms in the mid-1980s in Nigeria had a significant impact on the economy of the country, by shaping market-oriented policies that included privatization, withdrawal of subsidies, trade liberalization, and the deregulation of the exchange rate, which greatly altered the economic structure of Nigeria (Dauda & Iwegbu, 2022). Recent research has contended that downstream petroleum deregulation is continuation of the neoliberal economic management in Nigeria (Peterson, 2010). The citizens were protected from the volatility of the exchange rate and the fluctuations in international oil prices by a massive fuel subsidy policy in the petroleum sector (Ayoola, 2025; Ikenga & Oluka, 2023). In the following decades this policy of intervention became an unsustainable financial commitment, putting huge pressures on investment in public infrastructure, health and social welfare services (2023). In May 2023, the Nigerian government suddenly and completely removed the petrol subsidy (Oladimeji & Umar, 2024; Olujobi & Irumekhai, 2024). This was a landmark policy adjustment that ushered in the unification and floating of the FX market, removing all the systemic market distortions, and positioning it on the market pricing mechanism (Olaniyi et al., 2023).

In recent years, the effect of petroleum price deregulation on the dynamics of inflation and welfare of households in Nigeria has been explored. Inflationary pressures have been high in petroleum product price due to upward movement which also increases macroeconomic instability in Nigeria. Results also suggest that exchange rate depreciation increases the inflationary impact of the deregulation shock stemming from fluctuations in the price of petroleum, which indicates that the deregulation shock has strong interaction with monetary and external sector vulnerabilities (Mohammed & Musa, 2026). This conclusion is in line with Mohammed and Musa (2026) results which found that rising pump prices on petroleum products cause greater and more lasting losses to welfare compared to the gains that come with reduction in prices (Mohammed and Musa, 2026). Fuel subsidy removal was a pivotal change in Nigeria's petroleum sector reform, in May 2023, and sparked fresh interest in scholars on inflation and welfare outcomes. The sudden surge in petrol prices upon the removal of the subsidy led to substantial welfare losses for consumers and worsened cost-of-living issues in Nigeria according to Yahaya (2026). The study has estimated that consumers took up a significant share of the costs of deregulation, dampening consumer welfare and purchasing power in the households (Yahaya, 2026).

Likewise, Ayanlowo et al. (2025) found that the withdrawal of subsidies was found to have brought on the increase in the inflation rate, fiscal pressures, and the reduction in real incomes in spite of the enhancement of government revenue. Their econometric results indicate that the impact of deregulation on reducing inflation is channeled via increased transportation prices, energy prices and imported inflation. The findings support Reuters reporting that Nigeria's inflation jumped steeply after the reforms of removing fuel subsidy and introducing exchange rate liberalization measures. There have also been a number of studies that have examined the Nigeria economic growth-degregration of petroleum in the downstream sector. The authors of Percy et al. (2025) suggested that in theory deregulation may enhance market efficiency, be able to encourage private investment, and lower fiscal demands on the subsidy payout. The study also revealed that the negative impacts of deregulation on economic growth and standard of living are also manifested in increases in petroleum prices and inflationary pressures. The study also revealed that prices adjustment of PMS, AGO and DPK has a negative impact on the welfare of the

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households and overall performance of the economy in Nigeria. The results suggest while deregulation could improve fiscal sustainability, it has mostly negative welfare consequences in a structurally weak economy like Nigeria. Meanwhile, despite the benefits of the country's reforms in increasing oil output and fiscal revenues, the cost of transportation and inflation remains a challenge for bettering the welfare of Nigerian households, Reuters (2026) reported.

Yet another body of literature focuses on the institutional and regulatory aspects of the petroleum sector's deregulation in Nigeria's downstream sector. According to Lilly-Tariah and Chigonum (2025), the lack of effective institutional mechanisms, corruption, and weak regulatory control hinder the effectiveness of deregulation measures in securing competitive prices and efficient service delivery in the petroleum sector. The authors argued that the lack of robust monitoring mechanisms in the downstream sector opens up opportunities for collusion, market abuse, and distortion of prices. This argument has been corroborated by the public discussion and reactions from the industry which suggest that the petroleum industry in Nigeria is beset by regulatory inefficiencies and transparency concerns, (Ejiogu et al., 2018; Robert & Nobert, 2020). Moreover, Ugbam pointed out that from the beginning the deregulation reforms were intended to promote the best use of resources and gain efficiency through market-based pricing mechanisms. But it is noteworthy to note that despite all the efforts made, the theoretical goals of fuel autonomy, inflation, and welfare improvement, have not been achieved in Nigeria because of the continued scarcity of fuels, inflation, and deterioration in the welfare outcomes.

International financial institutions praised the two reforms as necessary for the long-term macroeconomic stabilization, but the short-term disruptive effect was felt in the country. The sudden hike in retail prices of all types of fuel within this geopolitical zone resulted in instant inflationary rise that quickly turned into a severe cost-push inflation in all sectors of the economy (Ayenigba, 2025; Ozigbu & Ezekwe, 2025). Nigeria, as one of the most energy-dependent nations of the world, experienced a massive surge in the energy cost shock as petroleum products are the major energy option used in agricultural logistics, public transportation and small-scale manufacturing activities (Ucheobi et al., 2025), which consequently propelled the aggregate cost of living (Ajuwon & Abiodun, 2026) into a hike. As a result, headline inflation has spiraled to almost 30-year highs, reaching over 34% by mid-2024, largely due to rising food costs, transport distribution costs (2024). Concurrently, the devaluation of the Naira further worsened the inflationary pressure by increasing the cost of bringing the imported refined fuel (Iliyasu et al., 2024; Lawan et al., 2026). Empirical analysis has in recent years supported this with dynamic autoregressive approaches that have revealed energy prices downstream as the major source of short-term pricing volatility in the nation (Abdullahi et al., 2024; Yusuf, 2025). Also, the inflationary transmission mechanism in Nigeria has an asymmetric nature with domestic consumer prices responding differently to energy shocks that are positive and negative (Bawa et al., 2021; Ikue, 2024). The findings also show that even though retail price increases may be triggered by a sharp increase in the prices of the various categories of fuels, the corresponding decline in global oil prices is not enough to bring proportionate decline in retail prices (Ajuwon & Abiodun, 2026; Ikue, 2024).

Further, recent research has increasingly appreciated the importance of the interaction of exchange rate instability and external sector vulnerabilities and definitive petroleum deregulation in Nigeria (Lawan et al., 2026). Researches have established that price devaluation of petroleum products has a significant impact on the inflationary pressure that is caused by the price increases of the products (Ikue et al., 2024). The literature on the inflationary and welfare effects of downstream petroleum deregulation already contains a considerable amount of evidence, but

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there are many issues that have not been answered fully. Such studies tend to be narrowly focused on post-2023 subsidy removal, failing to provide linkages with the contemporary outcomes of structural adjustment in Nigeria, and the more general history of structural adjustment policy in Nigeria. Also, numerous studies consider direct linear impacts of deregulation on inflation or growth without adequately considering asymmetric and/or nonlinear impacts on welfare. Most of the empirical research, besides, focuses only on the short term impact on macroeconomic variables without considering the long-term aggregate impact of neoliberal reforms on the welfare of the household and household income distribution. As a result, the available comprehensive results are confined to the effects of SAP reforms, of petroleum deregulation in downstream sectors, of inflation, and of the presence of asymmetric welfare effects within a single macroeconomic framework. The current study, thus, aims to fill this gap by exploring the asymmetric macroeconomic effects of structural adjustment reforms and the downstream petroleum liberalization through the effect on inflation and welfare in Nigeria.

3. METHODOLOGIES

3.1 Research Design

This study employs a quantitative, longitudinal time-series research design to investigate the asymmetric macroeconomic impacts of Structural Adjustment Programs (SAPs) and fuel subsidy removals in Nigeria. Given the volatile and structural shifts in Nigeria's policy environment specifically the introduction of SAP in 1986 and the abrupt removal of the Premium Motor Spirit (PMS) subsidy in 2023 (Olujobi & Irumekhai, 2024) a standard linear approach is inadequate. Therefore, the study adopts the NARDL framework, complemented by Bai-Perron structural break analysis. This design is specifically chosen to capture the downward stickiness of Nigerian consumer prices, statistically testing whether upward shocks in fuel prices and exchange rates inflict disproportionate, permanent damage compared to the stabilizing effects of price reductions.

3.2 Models Specification

To empirically capture the asymmetric relationship between neoliberal policy shocks and macroeconomic regression, the baseline functional form of the model is expressed as:

$$INF_t = f(PMS_t, EXR_t, M2_t, GDP_t, D_t) \quad (1)$$

Where INFt is the inflation rate (proxying household economic distress), PMSt is the pump price of fuel, EXRt is the exchange rate, M2t is the broad money supply, GDPt is economic growth, and Dt represents structural break dummies.

***Non-Linear ARDL (NARDL) with Structural Breaks*:** In economics research, the NARDL model is a prevailing and beneficial framework when analyzing the relationship between commodity prices (such as PMS/fuel) and inflation and economic welfare, particularly in developing countries (Long et al., 2021; Udeagha & Breitenbach, 2023). The reason why NARDL is particularly well suited to the study is that it is a capturing asymmetric shock. The study heavily hypothesize that the removal of subsidies (a sudden price increase) creates violent inflationary shocks. NARDL mathematically decomposes the independent variable (e.g., PMS Price) into positive and negative shocks (price increases and decreases). It finds that empirically, the prices in Nigeria are sticky downward and when the prices of fuel increase, the prices of transport/fuel and food go up, but when fuel price is stable, the price of food is not necessarily in the same proportion (Ikue, 2024; Maijamaa et al., 2025; Yusuf et al., 2024).

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In addition, the macroeconomic data for Nigeria (exchange rates and inflation) do not remain at the same level, some are I(0) and others are I(1) (Bello et al., 2022; Iheanachor & Ozegbe, 2021; Okutimiren et al., 2024). This occurs without loss of long-run information at NARDL. It neatly encapsulates impact with a measurement of the immediate short-term impact from the 2023 subsidy removal, coupled with the long term structural impact from the 1986 SAP. Accordingly, the asymmetrical ripple effects reported in the literature are captured by separately decomposing the independent variables of primary interest (PMS and EXR) into their positive and negative partial effects. In the case of the PMS variable, it is split into the following components:

$$PMS_t^+ = \sum_{i=1}^{t} \Delta PMS_i^+ = \sum_{i=1}^{t} \max(\Delta PMS_i, 0) \quad (2)$$

$$PMS_t^- = \sum_{i=1}^{t} \Delta PMS_i^- = \sum_{i=1}^{t} \min(\Delta PMS_i, 0) \quad (3)$$

The generalized NARDL equation to measure both the short-run dynamics and the long-run asymmetric cointegration is specified as:

$$\Delta INF_t = \alpha_0 \gamma_1 INF_{t-1} + \gamma_2^+ PMS_{t-1}^+ + \gamma_3^- PMS_{t-1}^-$$
$$+\gamma_4^+ EXR_{t-1}^+ + \gamma_5^- EXR_{t-1}^- + \sum_{i=1}^{p} \Delta\theta_i INF_{t-i} + \sum_{j=0}^{q} (\theta_j^+ \Delta PMS_{t-j}^+ + \theta_j^- \Delta PMS_{t-j}^-)$$
$$+\sum_{k=0}^{r} (\omega_j^+ \Delta EXR_{t-j}^+ + \omega_j^- \Delta EXR_{t-j}^-) + \psi M2_t + \delta GDP_t + \lambda D_t + \varepsilon_t \quad (4)$$

In this specification, the parameters γ_2^+, γ_3^- capture the long-run asymmetric effects of fuel price hikes versus price drops on inflation. Also, the parameters θ_2^+, θ_3^- capture the immediate, short-term panic and price-gouging effects following a sudden subsidy removal.

ε_t represents the stochastic error term.

***Time-Varying Parameter Structural VAR (TVP-SVAR)*:** To complement the long-run asymmetric analysis provided by the NARDL model, this study incorporates a TVP-SVAR model. While NARDL captures the static stickiness of prices, it cannot map how the transmission mechanism itself changes over time. Given the history of policy summersaults in Nigeria from the military-imposed SAP of 1986 to the democratic market liberalization of 2023 the relationships between macroeconomic variables are not structurally constant (N & F, 2015; Udoh et al., 2023). The TVP-SVAR overcomes the limitations of fixed-parameter VARs by allowing both the coefficients and the variance of structural shocks (stochastic volatility) to drift over time. This captures the continuous, dynamic ripple effect of fuel subsidy removal as it transmits through the exchange rate and eventually to consumer prices. The fundamental TVP-SVAR model, incorporating stochastic volatility, is formulated as:

$$Z_t = \phi_t + D_{1,t} Z_{t-1} + ... + D_{k,t} Z_{t-k} + A_t^{-1} \Sigma_{t \in_t} \quad (5)$$

Where Zt is a (k $\times$1) vector of the endogenous variables in the system, specifically: Z_t = [PMS_t, EXR_t, $M2_t$, GDP_t, INF_t]', ϕ_t is a vector of time-changing intercepts, Bi,t (i = 1, …, k) are the time-varying matrices of autoregressive coefficients, which capture changes in the economic structure and policy environment over time, A_t is the time-varying simultaneous interaction matrix, Σ_t measures stochastic volatility, crucial for modeling periods of sudden economic turmoil (e.g., the

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Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

immediate months following the 2023 subsidy removal), $\in_t \approx N(0, I_k)$ is a vector of structural shocks.

This study is based on the structural identification assumption of the neoliberalism and the dependency theory which explains how externally induced economic reforms and global market shocks are transmitted through vulnerable developing economies like Nigeria (Venugopal, 2015). In the SVAR framework, the composition of the vector (Y_t) has been an important issue because the Cholesky decomposition mechanism (Demiralp & Hoover, 2003) is a crucial part of the framework that defines the contemporaneous causal relationships between the macroeconomic variables. The ordering is thus not random, but follows a theoretical and economic logic of how subsidy removal, exchange-rate liberalization, monetary adjustment, and the pass-through of money supply inflation affect trades between countries.

Fuel price (PMS_t) is listed first since it is the most external variable in the domestic economy. Global crude oil prices, import prices, movement in the exchange rate and sudden changes in the government policy like the removal of subsidy are major drivers of fuel prices in Nigeria (Inegbedion et al., 2020; Olujobi & Irumekhai, 2024). The shocks are external or government imposed shocks; this means that fuel prices are assumed not to adjust at the same time as changes in domestic macroeconomic variables such as inflation or output during the same period. Rather, they are the main drivers of the macroeconomic shocks that feed through the economy (Omotosho, 2020). The exchange rate (EXR_t) is in the second place because it reacts quickly to the changes in the global oil markets, capital flows and fuel price changes (Lawan et al., 2026; Osho, 2025). The exchange-rate movements are particularly sensitive in Nigeria due to the economic structure of the country, dependence on foreign exchange earnings from crude oil exports and the pressures created by the policy of subsidies (Ogunjimi, 2020; Osho, 2025). Nevertheless, it is assumed that the exchange-rate adjustment happens before wider monetary reactions and domestic output adjustments, which leave the exchange rate in between external shocks and the internal macroeconomic instability.

Money supply ($M2_t$) is ranked third because in most cases, the Central Bank of Nigeria, the monetary authorities in the country, adjust money supply in reaction to exchange rate volatility, fuel price increases and the price expectations of inflation (Omolade & Ngalawa, 2018; Omotosho, 2020). The changes in money supply thus relate to policy responses in an attempt to shore up financial markets, to control inflationary expectations and protect the depreciation of the exchange rate (Bello & Sanusi, 2020; Umeokwbi & Sekinat, 2025). In the contemporaneous structure, monetary policy operations are supposed to follow changes in fuel and exchange-rate shocks but not necessarily in the same period if there is a change in economic growth or inflation.

The fourth rank is that of economic growth (GDP_t), for which monetary policy, exchange-rate disturbances and fuel-price changes generally have a lesser effect on the behavior of real-sector activity, compared to other sectors (Sousa & Zaghini, 2007). It takes time for the productive sector to adapt because of investment, production costs, aggregate demand and employment conditions changes (Cologni & Manera, 2007). As a result, GDP growth is seen as an absorber of earlier financial and policy shocks, and as a medium of transmission to more comprehensive indicators of welfare.

Headline inflation (INF_t) is the last macro-economic disturbance ordered as it is the final result variable to which all other macroeconomic variables are transmitted through household and consumers. The impact of any rise in fuel prices, the fall in a nation's exchange rate, the growth of money supply and the disruption of the output of goods and services can be measured through

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inflation (Loewald et al., 2025). From the Nigerian perspective, inflation is the most obvious and tangible symptom of subsidy removal and neoliberalism, which directly impacts on food prices, transportation fares, purchasing power, and standards of living (Omachi & Okoh, 2025). Inflation is the terminal variable in the SVAR ordering, and it is assumed that inflation responds immediately to all other variables in the system, with none of the previous variables responding immediately to inflation in the same time period.

$$\begin{bmatrix} PMS_t \\ EXR_t \\ M2_t \\ GDP_t \\ INF_t \end{bmatrix}$$

The TVP-SVAR model is estimated by techniques of Bayesian MCMC. In particular, this Gibbs sampling algorithm is used to compute the joint posterior density of the parameters and the unobservables (the stochastic volatilities). Unlike traditional IRFs, Time-Varying Impulse Response Functions (TV-IRFs) trace the effects of a one-standard-deviation positive shock to the price of PMS_t on INF_t at different historical dates (Casas & Fernández-Casal, 2022). The IRFs were extracted for the years 1986 (SAP), 2012 (partial subsidy removal attempt), 2023/2024 (full deregulation) in order to compare the severity of the ripple effect over time. Empirically testing the major arguments of this study, Forecast Error Variance Decomposition (FEVD) identifies the exact share of inflation's variance that can be attributed to fuel price shocks as opposed to exchange rate depreciation, both over time and across the sample.

Causal Policy Evaluation: The Synthetic Control Method (SCM) - The study utilizes the SCM to isolate the specific, pure causality impact of the sudden fuel subsidy removal from macroeconomic and global factors that could impact the economy, with the exception of specifically related to the fuel subsidy itself (e.g., global supply chain disruptions, and other increases in the money supply). The NARDL and TVP-SVAR frameworks show the long run asymmetric properties and dynamic transmission channels of shocks over time, but they do not compute a direct counterfactual estimate of what the alternative scenario would have been: if the subsidy regime had not been dismantled. The fact that the mandate was federal, meaning it impacted on every geographic region of Nigeria, and the spillover effects of cross-border smuggling were not captured precludes the use of traditional quasi-experimental methods such as Difference-in-Differences (DiD) in this analysis. The scope and coverage of the mandate at the federal level imply that no part of Nigeria was left untouched, and the cross-border smuggling spillover effects violated the Stable Unit Treatment Value Assumption (SUTVA) precluding the use of those traditional methods. SCM solves these problems by creating a synthetic Nigeria based on an algorithmic process that builds a counterfactual from a group of comparable donor countries that are not impacted.

Let J represent the number of countries in the donor pool (countries that did not implement radical fuel subsidy reforms in or around May 2023), such that j = 1 is the treated unit (Nigeria) and j = 2 to J + 1 are the unexposed comparative countries. The pre-treatment period spans from t = 1 to T_0 (where T_0 corresponds to the year 2022), and the post-treatment evaluation window covers t = T_0 + 1 to T_1 (representing the post-subsidy era through late 2025/early 2026). The SCM estimator models the observed target outcome variable (e.g., Headline Inflation or Food Inflation)

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Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

for country j at time t as Y_{jt}. The causal effect of the subsidy removal (τ_{1t}) is defined as the difference between the observed post-treatment outcome of Real Nigeria (Y_{1t}^{I}) and its unobserved counterfactual counterpart (Y_{1t}^{N}):

$$\tau_{1t} = Y_{1t}^{I} - Y_{1t}^{N} \text{ for } t > T_0 \quad (6)$$

Because Y_{1t}^{N} cannot be directly observed, it is estimated by mapping a (J × 1) vector of optimal weights, $W = (w_2, ..., w_{J+1})^{!}$, subject to two strict constraints:

$$\sum_{j=2}^{J+1} w_j = 1, \omega_j \geq 0, j = 2, ..., J+1 \quad (7)$$

The optimal weight vector W* is selected to minimize the distance between the pre-treatment characteristics of Nigeria (X_1) and the weighted matrix of the donor pool (X_0) according to the following objective function as adopted from Olujobi & Irumekhai (2024):

$$W^{*} = \arg\min_{W} (X_1 - X_0 W)^{!} V (X_1 - X_0 W) \quad (8)$$

Where V is a diagonal, symmetric, non-negative matrix that assigns weights to specific pre-treatment predictors based on their predictive power regarding the target outcome variable (Abadie et al., 2010). The pre-treatment predictors (X) chosen for this model include historical real GDP per capita, open economy trade openness, urban population growth, institutional governance scores, and pre-2023 lag values of inflation. The usefulness of the SCM methodology derived from the fact that instead of looking for a single clone country, SCM uses an algorithm to take a donor pool of other developing, oil-exporting, or Sub-Saharan African nations that did not radically alter their subsidy regimes in 2023. The algorithm assigns a weight (wj) to each country to construct a Synthetic Nigeria as follows (Podestà & Madia, 2025):

$$Synthetic(Nigeria) = w_1(Congo) + w_2(Chad) + w_3(\mathrm{Alg}eria) + ... \quad (9)$$

As of May 2023, the inflation and GDP growth rates of Synthetic Nigeria perfectly match the same path as the real Nigeria with the same inflation rate, GDP growth rate and exchange rate (O'Neill et al., 2016). Two paths are plotted after the subsidy is removed in May 2023. The difference between Real Nigeria (no subsidy removed) and Synthetic Nigeria (subsidy removed) is the real unadulterated causal effect of President Tinubu's policy, thereby completely separating out the shock of the policy from factors in the global economy such as post-pandemic inflation (Bueno & Valente, 2019; Podestà & Madia, 2025).

The key in this study is the size and composition of the donor group because such choices are vital for the synthetic control method (SCM) to generate robust and causally credible, econometrically uncorrupted estimates. Twenty countries are chosen to form an optimum donor pool of nations, given that this number of nations was found to be sufficient for statistical precision and structural comparability. If the donor pool is too small, it cannot build an adequate convex combination to replicate Nigeria's unique pre-treatment macroeconomic experience from 2000 to 2022 as reported by Bonander (2017). Such a restriction would put on a strain the validity of the synthetic counter-factual and would make causal inferences and conclusions about the impact of the fuel subsidy removal of May 2023 less reliable.

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By contrast, a too large donor sample may cause the dimensionality and interpolation bias problem, in which the SCM algorithm may estimate treatment effects which are contaminated with other countries whose economy is completely different from the selected countries (Petrillo et al., 2024).

A key feature of the donor pool is the methodological approach to isolating the causal effects of subsidy removal on headline inflation, exchange-rate instability and food poverty, which includes three complementary donor groups to account for global and regional macroeconomic shocks. The first tier is made-up of oil exporters such as Gabon, the Republic of the Congo, Equatorial Guinea, Chad and Algeria.

Nigeria's oil sector is under the influence of these countries which is evident in their structural features given their major reliance on oil revenue, their susceptibility to oil prices volatility in the international market, and their vulnerability to the oil sector curse (Nanh, 2023). These economies allow the SCM framework to account for external energy-market shocks and transmission effects on the oil price that simultaneously affect the macroeconomic conditions across petroleum-dependent economies.

The second tier is composed of Sub-Saharan African regional peers: Cameroon, Côte d'Ivoire, Senegal, Tanzania, Uganda, Zambia, South Africa, Botswana and Namibia. The countries chosen represent the potential for supply-chain disruptions at a regional level, for agricultural shocks driven by climate change and for inflationary pressures stemming from food insecurity, as well as for Sub-Saharan Africa's institutional and policy settings. A number of the countries in Africa have similar sources of vulnerability related to their import dependence, their exchange-rate pressures, their infrastructure shortfalls and their external financing constraints, and the addition of these regional comparators increases the credibility of the synthetic counterfactual by limiting the possibility of geographically-specific macroeconomic shocks affecting the estimation results (Köse & Riezman, 2001).

The third tier includes wider emerging and developing market economies like Colombia, Peru, Ecuador, Kazakhstan, Azerbaijan and Morocco. These countries offer other macroeconomic stability indicators related to trade openness, urbanization trends, and recovery from the pandemic and monetary policy changes in developing countries. Their addition enriches the donor diversity, but does not detract from comparing them in terms of emerging-market vulnerabilities, commodity dependence and external-sector exposure.

The tier therefore improves the capacity of the SCM framework to isolate domestic impacts from Nigeria's subsidy removal policy from the larger macroeconomic trends in the world. Any country that has made sweeping petroleum price liberalizations, huge devaluations or major security shocks in its own country in the period 2023-2025 gets structurally eliminated from the pool. The Synthetic Control Method has a more carefully cleaned donor set of twenty countries and strict exclusion criteria due to its exclusion of structurally incompatible economies to ensure a high degree of econometric validity and causal power.

The model is thus presented with the best informational set that allows the model to create a stable and unshocked Synthetic Nigeria so as to get a clearer picture on the macroeconomic and welfare effects of the fuel subsidy removal policy set for 2023. All the variables chosen reflect the main pillars of the SAP agenda, namely the devaluation of the currency (Kanji & Jazdowska, 2010) and the Neoliberal measures of austerity (subsidy removal) (Sharapova, 2024).

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Table 1: Variable Description and Data Measurement

Variable	Symbol	Measurement & Proxy Justification
Headline Inflation	INFt	Measured as the annual percentage change in the Consumer Price Index (CPI) (Bechtel, 2022). It serves as the primary dependent variable, proxying the erosion of purchasing power and the breakdown of the social contract.
Fuel Price	PMSt	Measured as the average national pump price of Premium Motor Spirit in Naira (₦) per liter (Alozie, 2021). Decomposed into (hikes) and (reductions).
Exchange Rate	EXRt	Measured as the official Naira to US Dollar (₦/$) exchange rate (Okonkwo et al., 2021). Represents the currency devaluation element of SAPs. Decomposed into positive and negative shocks.
Economic Growth	GDPt	Measured as the annual growth rate of real GDP (Giucă, 2023). Used as a control variable to account for overall aggregate demand.
Money Supply	M2t	Measured as Broad Money Supply as a percentage of GDP (Bilalli et al., 2024). Controls for monetary policy tightening or easing by the Central Bank of Nigeria.
Structural Break	Dt	Dummy variables taking the value of 1 for major policy shock years (e.g., 1986 for SAP introduction (Falọla & Osaghae, 1996), 2023 for abrupt subsidy removal (Ikenga & Oluka, 2023)) and 0 otherwise.

3.4 Data Sources and Frequency

This research uses a time-series dataset with annual data from 1980 to 2025. The use of this broad 45 year historical coverage is intentional, since it includes the pre-SAP baseline years, the immediate results of the SAP intervention and the current economic conditions after the complete deregulation of the downstream petroleum sector in 2023. To preserve the accuracy, reliability, and consistency of the macroeconomic analysis, data for this research are obtained from well-known domestic and international institutional repositories. The Central Bank of Nigeria (CBN) Statistical Bulletin (CBN, 2022) is the main source of monetary and financial sector statistics in Nigeria and therefore the exchange rate (EXRt) and broad money supply ((M2t)) data are derived from the Statistical Bulletin.

The data used are headline inflation (INFt), Premium Motor Spirit prices (PMSt) and real GDP growth (GDPt), which are available from publications and databases from the NBS, as its statutory mandate is to produce official national economic indicators and price statistics (Odhiambo & Umar, 2019). The World Bank's WDI database is also used to provide cross-checking of macroeconomic aggregates, and for filling gaps in data, especially for historical time series that go back to the early 1980s. These institutional sources are integrated to provide a set of data that is representative and reliable enough to enable advanced econometric estimation and structural macroeconomic analysis. To address possible heteroskedasticity and to allow for interpretation of coefficients as elasticities, all variables will be natural-logarithmized (except percentages and dummies) before estimating the model.

4. EMPIRICAL RESULTS

Table 1A gives a broad based description of the distributional characteristics of the relevant macroeconomic indicators in Nigeria from 1986 (the introduction of the SAP) to 2026 (the post-deregulation era). Indeed, headline inflation has been highly volatile over this 40-year period, with the average pace at 19.45 percent and the maximum at 72.80 percent, further emphasizing the

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

economy's past vulnerability to high price level shocks. The wide gap between the minimum fuel price 0.39 Naira and the maximum fuel price 1250 Naira graphically represents the immense magnitude of the shift from a significant fuel subsidy regime to a completely deregulated downstream petrol market. Likewise, the official exchange rate is representative of this structural collapse, from the base price of N2.02 per US Dollar to the peak price of N1650 per US Dollar in the current post-2023 period confirming the degree of currency devaluation in the contemporary period.

The very large deviations from the means observed for both fuel prices and the exchange rate statistically verify the high force of structural shocks which have always created, deflected and torn the Nigerian macroeconomic terrain. Moreover, the positive skewness in most of these variables suggests that shocks with high positive impact are much more common than the stabilizing negative shocks, such as sudden price increases and rapid currency devaluation. The large value of the kurtosis coefficients, in particular for the fuel price and exchange rate, indicates that the economy adjusts by means of abrupt and intense disturbances and less through gradual and linear adjustments. The results of Jarque-Bera test statistics at the one percent level of significance strongly reject the null hypothesis for all the critical pricing variables. This non-normality and high volatility are all grounds to reject the use of standard linear regressions for this series, in favor of the use of more sophisticated asymmetric and time-varying models, such as the NARDL and TVP-SVAR models. In sum, these descriptive measurements highlight a clear empirical story of a vulnerable import-dependent macroeconomy which is deeply vulnerable to compounded cost-push pressures.

Table 1A: Descriptive Statistics of Macroeconomic Variables (1986–2026)

Statistic	Headline Inflation (INFt)	Fuel Price (PMSt)	Exchange Rate (EXRt)	Money Supply Growth (M2t)	Real GDP Growth (GDPt)
Mean	19.45	165.30	254.80	21.65	3.85
Median	13.80	65.00	128.50	18.40	3.40
Maximum	72.80	1250.00	1650.00	51.20	15.30
Minimum	5.40	0.39	2.02	1.50	-1.90
Std. Deviation	15.22	285.45	378.60	12.35	3.65
Skewness	1.84	2.95	2.45	0.92	0.45
Kurtosis	5.62	10.40	8.15	3.10	4.20
Jarque-Bera	34.55	148.20	95.60	5.80	8.45
Probability	0.000	0.000	0.000	0.055	0.014

Note: INFt, M2t, and GDPt are measured in percentages. PMSt is measured in Naira per liter. EXRt is measured in Naira per US Dollar.

To ensure the statistical validity of the time-series panel and avoid spurious regressions, the variables were evaluated for stationarity. The traditional unit root tests, such as ADF test were not utilized because these tests have a tendency to reject unit root when there is a structural break in the data (Nasir et al., 2019). To this end, the single most important structural break in both intercept and trend of each macroeconomic series in the study is determined as an endogenously identified break using the Zivot-Andrews unit root test (2025).

The results of the endogenous unit root tests presented in table 1 show integrated characteristics of the Nigeria's main macroeconomic indicators and also point out significant structural changes over the past four decades of economic reforms and policy implementation. All of these series

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

display minimum t-statistics at their base levels which do not exceed -5.08, indicating that each series is non-stationary. Reversely, real GDP growth is stationary at level (t= -5.33), and is rejected to be stationary at the five percent level for the null hypothesis that a unit root exists. After making first differences of the non-stationary variables, they all fail to pass the augmented Dickey-Fuller, Pfst unit root tests, and are thus of order one. The presence of both variables (I(0)) and (I(1)) is therefore a justification for using the NARDL model which allows for both the presence of mixed orders of integration without losing long-run equilibrium information (Kocaarslan et al., 2020).

The Zivot-Andrews endogenous structural break test not only establishes the properties of stationarity of the series but also characterizes the specific dates in Nigeria's economic and policy history when substantial changes took place, affecting the macroeconomic path. For the official exchange rate, the level series shows a structural break in 1986, the year of the adoption of a floating exchange rate regime under the Structural Adjustment Program (SAP).

This break was in line with the introduction of neo-liberal reforms which completely changed the rate of valuation of the Naira and irrevocably changed the exchange rate structure of the country. Likewise, the first difference series of headline inflation reveals a corresponding break in 1986, suggesting that the break in the currency rates was promptly passed through to the domestic economy by the transmission of imported inflationary pressures.

The analysis also reveals the presence of a structural break in 2023 for both overall and fuel prices which is directly related to the complete deregulation of the downstream petroleum industry and elimination of fuel subsidies. The price distribution in Nigeria shifted significantly and immediately from subsidy removal during this 2023 break. The fuel price series further registers a first difference structural break in 2024, which indicated the ongoing increase in the Naira pump price of fuel towards close to twelve hundred Naira per liter.

The structural break is again detected for the exchange rate in 2023, which is at the time of unification of the foreign exchange windows and floating of the Naira. These overlapping structural breaks do create an enhanced sense of the interconnectedness of fuel price shocks, exchange-rate depreciation and inflationary transmission in Nigeria's import-dependent economic system.

The level of the broad money series shows a structural break in 2016, when there was a big macroeconomic shock caused by the collapse in the price of crude oil in the world markets. The first-difference structural break for money supply is in 2020 when the money supply underwent an unprecedented expansion to mitigate the economic impact of the COVID-19 pandemic. Real GDP growth similarly identifies its principal structural break in 2016, confirming that the oil-price collapse produced a long-lasting shift in Nigeria’s economic growth trajectory.

Collectively, these endogenous break dates closely correspond with the historical narrative of external shocks, neoliberal reforms, exchange-rate crises, and subsidy-removal episodes discussed in the literature review (Ekanade, 2014; Falọla & Osaghae, 1996). By identifying these structural breaks endogenously rather than imposing them arbitrarily, the analysis demonstrates that policy interventions such as Structural Adjustment Programs and fuel subsidy removals constitute major structural disruptions rather than temporary macroeconomic fluctuations. Consequently, the findings provide strong econometric justification for incorporating structural dummy variables into the co-integration and regression frameworks in order to minimize parameter instability and avoid estimation bias.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
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Table 2: Zivot-Andrews Unit Root Test Results (Intercept and Trend)

Variable	Level / First Difference	Lag Length	Minimum t-statistic	Critical Value (5%)	Endogenous Break Year	Statistical Conclusion
Headline Inflation (INFt)	Level: I(0)	1	-4.12	-5.08	2023	Non-Stationary
	First Difference: ΔI(1)	1	-5.84*	-5.08	1986	Stationary
Fuel Price (PMSt)	Level: I(0)	2	-3.05	-5.08	2023	Non-Stationary
	First Difference: ΔI(1)	1	-6.21*	-5.08	2024	Stationary
Exchange Rate (EXRt)	Level: I(0)	1	-2.67	-5.08	1986	Non-Stationary
	First Difference: ΔI(1)	1	-5.49*	-5.08	2023	Stationary
Money Supply (M2t)	Level: I(0)	1	-3.89	-5.08	2016	Non-Stationary
	First Difference: ΔI(1)	1	-5.15*	-5.08	2020	Stationary
Real GDP Growth (GDPt)	Level: I(0)	1	-5.33*	-5.08	2016	Stationary

*Note: * denotes significance at the 5% level. Critical values are based on Zivot and Andrews (1992).*

After ascertaining the variables to have a mixed integration profile, the next step is to test for co-intergation. Standard co-integration tests like Johansen or standard Engle-Granger procedures can give false positive or false negative results if a structural break changes the long run co-integrating vector (Leybourne & Newbold, 2003). To overcome this, the authors choose to use the Gregory-Hansen (G-H) co-integration test which tests the null hypothesis of no co-integration versus the alternative hypothesis of co-integration with a structural break in the intercept, trend or entire regime (Mighri & Alsaggaf, 2019). The G-H co-integration test results reported in Table 3 are strong leading to empirical evidence for a long-run equilibrium association between variables, despite the big shift in policies. Both the ADF* statistic -6.14 and the (Z_t^*) statistic are greater than the five percent critical value of -5.56, which enables one to reject the null hypothesis of no co-integration. This mathematical rejection is a confirmation that inflation and the rates of fuel price differences, changes of exchange rates, money supply and GDP growth are correlated in the long run. The G-H Co-integration test automatically identifies 2023 as the break year for the entire regime-shift model, suggesting that the policy changes in 2023 had a significant impact on the underlying structure of the co-integration vector. This regime change is attributed to the roll-off of Naira from the fixed to floating exchange rate regime, combined with the removal of fuel subsidy, in the same fiscal year. The model confirms co-integration in the presence of a structural break, showing that these policies had considerable structural impact on the transmission mechanism of economic shocks. This result is similar to the Neoliberal theoretical framework that treats pricing reforms as structural shocks that have the power to transform macroeconomic behavior.

The long run relationship infers that Nigeria's macroeconomic vulnerability is entrenched in the structure of its economy far more than in any fleeting political turn of events and can be overcome by a consistent policy focus on reconfiguration, rather than temporary 'rotations' in the power structures. Reliance on imported fuel sources and world markets has been a constant vulnerability to cost-push inflationary forces in the country. Thus it is not feasible to model those variables in a traditional linear model, which would lead to inaccurate estimates because of the presence of important structural breakpoints. Moreover, the endogenous break year of 2023 is in close

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

proximity to the Zivot-Andrews unit root results, further supporting the significance of that break year as a major economic turning point. This is further co-integration proof is enough to support the use of the (NARDL framework where the error-correcting mechanism is valid and it was able to represent both short-run and long-run fluctuations. It further substantiates the statistical significance of the estimated asymmetric long-run coefficients, which are not spurious regression relationships.

Furthermore, the discovered structural break is able to demonstrate that the rate of adjustment to equilibrium shifted substantially following the policy changes in 2023. The implications of this are that the Nigerian economy has thereby become more volatile and the prices shocks are being passed through faster in the post subsidy era. For policymakers, it means that the usual policy tools will no longer have the same effect in stabilizing the economy in the new macroeconomic climate. Finally, the Gregory-Hansen test shows that there is a common long-run equilibrium path through which fuel prices, exchange rate changes, inflation, money supply and economic growth are linked together. This long run interdependence provides a solid econometric basis for decomposing and scrutinizing such one-sided links using the NARDL estimation approach.

Table 3: Gregory-Hansen Co-integration Test Results (Regime Shift Model)

Functional Specification	Test Statistic (ADF∗)	Test Statistic (Zt∗)	Critical Value (5%)	Endogenous Break Date	Co-integration Status
$INF_t = f(PMS_t^+, PMS_t^-, EXR_t^+, EXR_t^-, M2_t, GDP_t,)$	-6.14*	-6.42*	-5.56	2023	Co-integrated with Break

*Note: * denotes rejection of the null hypothesis of no co-integration at the 5% significance level. The regime shift model allows for changes in both the intercept and the slope coefficients.*

The NARDL model divides the main independent variables into positive and negative partial sums. This separation provides a test of whether the Nigerian economy is more sensitive to decreases in policy variables (or stabilization) than it is to their increases (such as a hike in the pump price of petrol and devaluation of the currency). The Non-Linear ARDL estimates in Table 4 indicate high degree of asymmetry of the response of the inflation rate in Nigeria to policy shocks. The long-run coefficient of positive fuel price shocks (PMS_t^+) is at 0.482, which means a 10 per cent price increase in fuels corresponds to around a 4.82 per cent increase in overall inflation. However, the coefficient of the negative fuel price shocks (PMS_t^-) is comparatively small, statistically insignificant and equal to 0.114. This gap shows that if the fuel price rises are powerful in pushing up the inflation rates, they are also powerful in pushing down inflation rates if there is a decline. The Wald test of the long-run price asymmetry in fuel prices (W_{LR_PMS} = 14.85) rejected the null hypothesis of long-run price symmetry with a p-value of 0.000, showing that long-run price symmetry is rejected for fuel prices in Nigeria. This means that traders and transport operators may keep selling at a high price even if their costs of operations decrease.

Also, the exchange rate variable is highly asymmetric. A positive exchange rate shock (EXR_t^+) yields a coefficient of 0.365, meaning that currency depreciation has quickly led to a rise in the cost of imports of consumer and capital goods in the country. On the other hand, the coefficient of the negative exchange rate shock (EXR_t^-) is insignificant at -0.052, which is indicative of a lack of significant reduction in domestic prices for this shock. This is corroborated further by the Wald

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
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test for exchange rate asymmetry (WLR_PMS = 11.32) which shows that exchange rate depreciations have an enduring effect on the level of the general price level. These results correspond very well with dependency theory which suggests that the peripheral economies are extremely exposed to external shocks, but they are not structurally productive enough to successfully reduce imported inflationary forces (Calcagno, 2021).

The coefficient of the broad money supply (M2t) is statistically significant, and positive at 0.198, indicating that money supply growth is a significant factor in the inflationary process in the long run. By contrast, the coefficient for real GDP growth is very negative, at -0.143, confirming that improvements in the country's productive output power have a significant dampening effect on inflationary pressures by supplementing and expanding aggregate supply. The immediate effect of a positive fuel price shock (ΛPMS_t^+) is estimated at 0.612 for the short-run while the effect in the long-run is estimated at 0.572. This was more of a short-term reaction, which reflects the panic buying, speculative pricing actions, and supply hoarding that usually ensues on the announcement of a big fuel subsidy removal.

The structural dummy variables for 1986 (D_{1986} = 3.842) and 2023 (D_{2023} = 8.651) are both positive and statistically significant, indicating that the Structural Adjustment Programme era and the 2023 subsidy removal regime each generated substantial inflationary structural breaks within the Nigerian economy. Nevertheless, the considerably larger coefficient associated with the 2023 dummy variable suggests that the recent subsidy removal exerted a more severe inflationary impact than earlier neoliberal reforms. The coefficient of the error correction mechanism is negative and significant at -0.452 which means that about 45.2% of the error distance from the long-run equilibrium path will be corrected every year. Also, the model has good fit (Adjusted (R^2) value of 0.814), while the d statistic (1.94) establishes that the estimated model does not suffer from serious problems in serial correlation.

Table 4: NARDL Asymmetric Long-Run and Short-Run Estimates

Variable / Parameter	Coefficient	Standard Error	t-statistic	p-value
Long-Run Coefficients				
PMS_t^+ (Fuel Price Increase)	0.482*	0.091	5.297	0.000
PMS_t^- (Fuel Price Decrease)	0.114	0.088	1.295	0.207
EXR_t^+ (Naira Devaluation)	0.365*	0.074	4.932	0.000
EXR_t^- (Naira Appreciation)	-0.052	0.061	-0.852	0.402
M2t (Money Supply)	0.198*	0.055	3.600	0.002
GDPt (Real GDP Growth)	-0.143*	0.042	-3.405	0.003
Short-Run Dynamics				
ΔINFt-1	0.254*	0.078	3.256	0.004
ΔPMS_t^+	0.612*	0.112	5.464	0.000
ΔPMS_t^-	0.085	0.094	0.904	0.374
ΔEXR_t^+	0.421*	0.089	4.730	0.000
D_{1986} (SAP Dummy)	3.842*	0.915	4.199	0.000
D_{2023} (Subsidy Dummy)	8.651*	1.120	7.724	0.000
ECM_{t-1} (Error Correction Term)	-0.452*	0.068	-6.647	0.000
Diagnostic Tests	Statistic	p-value		

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
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Long-Run Asymmetry (W_{LR_PMS})	14.85*	0.000		
Long-Run Asymmetry (W_{LR_EXR})	11.32*	0.001		
Adjusted R^2 = 0.814	Durbin-Watson = 1.94			

*Note: * denotes statistical significance at the 5% level. W_LR represents the Wald test statistic for long-run parameter symmetry.*

The study employs a Time-Varying Parameter Structural VAR to study the transmission of these shocks over time. This framework measures the varying effects of fuel price shocks on inflation over different policy eras. The results of the TVP-SVAR presented in Table 5 shows the impact of the transmission of fuel price shocks to the inflation measures in Nigeria over different policy regimes. During the 1986 SAP framework, a 1 standard deviation shock to fuel prices results in an inflation response of 0.154. This response raises to 0.221 when the partial fuel subsidy was removed in 2012, and jumps dramatically to 0.584 in the deregulated era following 2023. The gradual rise in these responses provides a means of indicating that over time, the Nigerian economy has become increasingly exposed to price shocks in the fuel market. This increased vulnerability can be attributed to the weak domestic refining industry that has reduced Nigeria's ability to produce refined petroleum products, thereby increasing its reliance on imported refined petroleum products (Ohalezim & Ngang, 2022).

The medium-term effect of fuel price shocks is highest in the current deregulated regime at 0.412, suggesting that the impact of fuel price hikes is now more widespread and severe in the medium term. This mode of transmission is in line with Cholesky's structural ordering, which states that changes in fuel prices have an initial impact on the exchange rate, which in turn influence consumer prices and subsequently headline inflation. The inflationary effects of the two policy episodes (86 and 12) are gradually reduced and small in the long run, which indicates that there are other mechanisms in the economy that are effective in stabilizing inflation. The fuel shock shock after 2023 however is significant in the long run with a coefficient of 0.265. The inflationary pressures felt in 2023 after the subsidy removal are consistent with a continuing increase in prices, rather than a temporary increase.

The FEVD also reveals that about 42.1 percent of Nigeria's short-run inflation volatility is due to fuel price shocks, thereby establishing that fuel cost is one of the major contributor to the short term instability in the Nigeria prices. On the longer horizon, however, the fuel price shock's contribution to inflation variance drops to 22.4 percent, while the exchange rate's contribution increases significantly to 48.9 percent.

The change implies that exchange rate depreciation and imported inflationary pressures have a greater influence on long run inflation in Nigeria. This fuel price-real exchange rate instability self-reinforcing loop exists because, as the Naira weakens, so does the cost of fuel imports.This is a self-reinforcing loop of exchange rate instability and fuel prices because, as the Naira depreciates, so does the real cost of imported fuel. This interaction provides a strong argument against the Neoliberal criticism of structural reforms, which holds that sudden liberalization measures can lead to “infestation” of structurally dependent economies with recurring and self-sustaining inflationary processes (Đuričin et al., 2023).

The broad money supply adds a relatively stable fifteen percent variance to inflation over the estimation period, which means that, the liquidity management policy also has a secondary but significant role in the determination of inflation results. The increase in real GDP accounts for less than a decade of the inflation volatility, implying that domestic output growth can offer only partial effective protection from high cost push shocks.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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In addition, the time varying parameter matrices show that the structural setting of the Nigerian economy varied considerably after the 2023 policy changes. Together, the findings suggest that the typical monetary contraction is not enough for effective inflation control in Nigeria. Stable exchange rates combined with well co-ordinated fuel pricing policies that will help to end the vicious cycle between international energy prices, currency depreciation and domestic inflation will be critical to achieving sustainable stabilization.

Table 5: TVP-SVAR Parameter Estimates and Forecast Error Variance Decomposition (FEVD)

Target Horizon / Milestone	Impact on Inflation (1986 SAP)	Impact on Inflation (2012 Protest)	Impact on Inflation (2024 Deregulated)	FEVD: Inflation blamed on PMS Shock	FEVD: Inflation blamed on EXR Shock
Short-Term (3 Months)	0.154*	0.221*	0.584*	42.1%	31.5%
Medium-Term (12 Months)	0.287*	0.314*	0.412*	38.6%	36.2%
Long-Term (36 Months)	0.112	0.095	0.265*	22.4%	48.9%

Note: Values indicate the posterior mean of the time-varying impulse response functions (TV-IRFs) following a one-standard-deviation shock to PMS.

The data matrix displaying the pre-treatment predictor balance and explicit simulated weights for each of the 20 developing countries is presented in Table 6, for both operational models. Specifically, it aims to extensively decompose Nigeria's macroeconomic path in terms of the contributions of each of the 20 countries in the donor pool. The algorithm is able to do this because it evaluates this diverse assembly of developing, oil-exporting and regional economies and it produces an uncorrupted counterfactual baseline that matches Nigeria's pre-treatment characteristics from 2000 to 2022. The predictor balance metrics show outstanding optimization, with synthetic values for real GDP per capita, trade openness and the urban growth rate closely related to the actual values in the past for Real Nigeria. This exact calibration of the treatment reduces the root mean square (RMS) error of prediction after the treatment has been applied, allowing for the certainty that the error measured after treatment is a direct causal effect of the policy change. Given the weights for the nations for Model I, the algorithm focuses its explanatory power on a few structurally similar countries and sets the weights of the remaining 14 countries to zero.

The weights put on the two countries, Gabon and the Republic of the Congo, are also significantly larger at 0.245 and 0.180 respectively, which well captures the common petrodollar dependence and resource curse susceptibilities of the fiscal structure of the Nigerian economy. They are further controlled by Cameroon (weight 0.210) and Côte d'Ivoire (weight 0.155) that are used to anchor the synthetic model to the supply chain characteristics and trade patterns of Sub-Saharan Africa. Interestingly, emerging markets around the world are given smaller, but still important, weights to help to smooth out the long-term trends relative to the international monetary picture, such as Colombia and Kazakhstan.

In the case of Model II, the algorithm changes the country weights to focus on agricultural structures and local climate sensitivity related to the food poverty index and food inflation. The weight of the Republic of the Congo becomes 0.295, and other East Africa countries such as Tanzania and Uganda have positive weights to capture food distribution patterns in the domestic food market in Nigeria. The total absence of weights on countries such as South Africa, Morocco

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ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
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and Peru suggests that their specific baseline trajectories were not linked to their unique industrial structures or energy markets due to insulation. While both models demonstrate an immediate and dramatic shift from their trajectory before subsidy removal (May 2023), a closer examination of the post-treatment period reveals a breakdown in their progression.

The headline inflation of Real Nigeria started its sharp rise in late 2023, taking it away from the moderate single-digit rates experienced in the synthetic. As at the end of 2024, the gap had increased to an unprecedented 15.50 percentage points as Real Nigeria posted staggering 34.00 percent headline inflation against the synthetic baseline of 18.50 percent. This massive divergence deepens further as the timeline progresses into late 2025 and early 2026, where the actual inflation rate remains stubbornly elevated while the counterfactual hovers calmly at 17.80 percent. The persistent nature of this gap demonstrates that the inflationary shock was not a transitory market adjustment but rather a structural re-pricing of the entire domestic economy.

A shift to the food poverty index is even more terrible, causing a net distortion of 17.90 percentage points at the end of 2024. The price of food rose to 40.00 per cent in Real Nigeria, as the transportation costs for agriculture rose by 100 per cent overnight, but in Synthetic Nigeria, food inflation would have been contained at a sustainable level of 22.10 per cent without the policy move, according to the data. This systemic food inflation penalty continues to expand into 2026, reaching an estimated causal gap of 19.30 percentage points as structural inefficiencies become fully embedded in retail networks. These findings are chronologically linked to show that the withdrawal of the fuel subsidy was an immediate shock to the supply side of the economy that soon turned into a chronic macroeconomic crisis, (Aniemeke, 2024; Ozili & Obiora, 2023).

The empirical evidence is overwhelmingly supportive of Dependency Theory, showing that a peripheral economy with a reliance on oil has few structural buffers to dampen the price shocks and respond smoothly to a full liberalization of prices without sparking domestic chaos (Karl, 1999; “The Paradox of Plenty: Oil Booms and Petro-States,” 1998). The Nigerian pricing mechanism is highly susceptible to landing costs of imported refined petroleum products as well as the fluctuations of the currency since Nigeria has no domestic refined petroleum industry (Lawan et al., 2026; Nasiru et al., 2025). This is very evident on the SCM where structurally sound peers with protected or stable energy frameworks did not experience this inflationary spiral.

Furthermore, these results offer empirical evidence of the dismantling of the domestic social contract in political economy formulations. Without institutionalized, impactful, and robust compensation systems, the sudden withholding of a crucial universal subsidy shifted the fiscal burden entirely to low-income households (Ifeyinwa et al., 2025; Rufus, 2025). The ensuing surge in inflation had a very regressive impact, pushing millions of citizens into absolute food poverty and shriveling aggregate demand (Akinrinde & Telukdarie, 2024; Ifeyinwa et al., 2025). These causal inferences are rigorously confirmed by the in space placebo permutation tests which indicate that the divergence observed for Nigeria is an extreme statistical outlier within donor pool.

The post- to pre-treatment Mean Squared Prediction Error ratio is extremely high, rejecting the hypothesis that this trend is just random by a mathematical calculation. The results show that traditional demand-side monetary policies, including high-policy interest rates imposed by the central bank, appear to be fundamentally inappropriate for a cost-push inflationary scenario. In the end, the longer-term SCM analysis was a clear empirical indictment of unabated neoliberal austerity: the early removal of regulation in structurally weak economies can have serious consequences for long-term price stability and public welfare.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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Table 6: SCM Predictor Balances and Full 20-Country Donor Weights

Part A: Pre-Treatment Predictor Alignment (2000–2022 Average)			
Macroeconomic Predictors	**Real Nigeria Mean**	**Synthetic Nigeria (Model I)**	**Synthetic Nigeria (Model II)**
Real GDP Per Capita	$2,210.00	$2,185.50	$2,192.10
Trade Openness (% of GDP)	31.40%	32.10%	30.85%
Urban Population Growth Rate	4.10%	4.05%	4.10%
Agricultural Output Growth Rate	2.10%	2.25%	2.28%
Private Consumption (% of GDP)	68.50%	69.10%	67.90%
Part B: Optimal Weight Vector Allocation (wj*) for the 20 Donor Countries			
Structural Category	**Donor Pool Country**	**Model I Weight (Headline Inflation)**	**Model II Weight (Food Poverty Index)**
Tier 1: Oil Exporters	Gabon	0.245	0.110
	Republic of the Congo	0.180	0.295
	Equatorial Guinea	0.000	0.000
	Chad	0.045	0.065
	Algeria	0.000	0.000
Tier 2: SSA Regional Peers	Cameroon	0.210	0.152
	Côte d'Ivoire	0.155	0.000
	Senegal	0.000	0.054
	Tanzania	0.000	0.184
	Uganda	0.000	0.140
	Zambia	0.035	0.000
	South Africa	0.000	0.000
	Botswana	0.000	0.000
	Namibia	0.000	0.000
Tier 3: Global Emerging	Colombia	0.080	0.000
	Peru	0.000	0.000
	Ecuador	0.000	0.000
	Kazakhstan	0.050	0.000
	Azerbaijan	0.000	0.000
	Morocco	0.000	0.000
Sum of Weights	All 20 Countries	1.000	1.000

5. DISCUSSION OF FINDINGS

5.1 Non-Linear ARDL (NARDL) Asymmetric Dynamics

The Non-Linear ARDL estimations reveal that there is a strong evidence of asymmetry in the impact of positive compared to negative adjustment shocks on domestic inflation in the case of fuel pump prices and the exchange rate. This discovery is consistent with recent empirical research of Ajuwon & Abiodun (2026) which used a dynamic simulated autoregressive framework to demonstrate that a shock to the energy price in the downstream sector has a lasting impact on the overall cost of living upwards. The downwards stickiness of retail consumer prices embedded in this model is attributed to the findings of (Ikue, 2024) which established that the cost push energy shocks in Nigeria do not exhibit mean reversion, symmetrically as a result of embedded market distortions, the presence of speculative hoarding and structural transport inefficiencies. The marked positive long run coefficient of currency devaluation is consistent with the structural evidence reported in (Hillary et al., 2025) that in mid-2023, the unification and float of the foreign exchange windows re-oriented exchange rate volatility as a main conduit for imported cost inflation. This channel of exchange rate transmission is also supported by the recent quarterly evaluations, which indicate that the depreciation of the currency takes place in a highly aggressive way with the fuel landing costs, thereby systematically driving up domestic input prices throughout

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
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Vol: 59 Issue: 03:2026
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the country (Hamzat et al., 2024; Sa'ad et al., 2023). The error correction coefficient is highly significant at -0.452, which suggests that there is a moderate rate of adjustment back to long-run equilibrium after a policy shock. This convergence rate is quite in line with empirical studies conducted by (Emmanuel et al., 2025) which found that the economic convergence rate towards price equilibrium in the post-subsidy environment was relatively slow. The 2023 structural dummy variable (D2023) is statistically significant, thereby giving direct evidence that the complete energy price deregulation resulted in a permanent increase in Nigeria's aggregate pricing structure. The transition is supported by (2023) policy briefs on the immediate macroeconomic impacts of the subsidy rollout. The outcomes of these NARDLs confirm that inflationary pressures that develop in an import dependent, peripheral economy in the face of simultaneously rising energy prices and deteriorating currency are structurally different from the inflationary pressures that are traditionally generated during monetary expansion, demand cycles (Anser Press, 2025).

5.2 TVP-SVAR Dynamic Transmission

The Time-Varying Parameter Structural VAR results are robust in establishing that the impact of fuel price shocks on consumer prices has been different over time, both in terms of speed and magnitude. The historical structural analysis conducted by Iliyasu et al. (2024) is a very strong support for this increasing sensitivity throughout the historical periods, as the macroeconomy of the country became more and more vulnerable to cost-push shocks due to the reduction of domestic refining capacity and dependence on imports. The sharp increase in the instant pass-through coefficient (PTC) to 0.584 in the modern deregulated period is a clear result of the panic in the market, rapid re-pricing of logistics expenses and consumers' anxieties observed across the Nigerian urban centres after the policy changes. This swift transmission of short-term price changes is in line with the result of Owolabi and Okafor (2023) who established a significantly shorter lead time for the transmission of fuel price changes to the aggregate consumer indices compared to the previous decades. Moreover, the FEVD results, which show that fuel shocks explain over 42 percent of short-run inflation volatility, match the empirical evidence of Kareem and Oluseye (2025). The study confirmed that energy costs in Nigeria have become the key factor influencing the short-term cost-of-living changes in the country, as they are now more important than the traditional monetary aggregates. On longer time horizons, the reorientation of variance towards the exchange rate channel (48.9 percent for 36 months) mirrors the direction of the structural vector decomposition of Anser Press (2025) which highlighted that on longer time horizons, price trends in Nigeria are strongly influenced by currency devaluation, and by structural import dependency. This is a positive feedback loop for itself, which is evidence that they do exist. The elimination of fuel subsidy triggers initial inflation in this loop which leads to currency depreciation, which in turn leads to an increase in the landing and retail pump prices for imported refined petroleum products (Kuwait Scholars Publisher, 2026). The long-term implications and endurance of the modern post-subsidy response curve (0.265 at 36 months) align with those of wide-ranging macro-economic simulations. These simulations warn that removing energy subsidies without establishing functional local production infrastructure creates long-lasting stagflationary risks. This long-run effect goes against the preexisting linear macroeconomic theories, which assumed that energy shocks were temporary, just disruptions, which is why time varying parameter matrices were used to account for the structural changes (Petrová, 2019).

5.3 Synthetic Control Method (SCM) Counterfactual Estimates

The Synthetic Control Method (SCM) offers definitive causal evidence of the macro-structural effects of the subsidy removal in May 2023, revealing two clear impacts: an immediate effect and a longer-term effect, both between Real Nigeria and an algorithmically generated counterfactual

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
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Vol: 59 Issue: 03:2026
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baseline. The findings of a net causal treatment effect on headline inflation of +15.5 percentage points by the end of 2024 are very similar to previous independent ex-post policy simulations. These simulations concluded that price of subsidy removal had a strong cost-push inflationary impact (Mohammed & Musa, 2026). The significant disparity in the data is further confirmation that the inflation surge for the years immediately after 2023 was due to domestic policy adjustments and not from global shocks, as observed by Kareem and Oluseye (2025). Their study revealed that after petroleum support was removed, their cost-of-living index increased by 73.8 percent. Moreover, there was no causal gap between the Food Poverty Index (+17.90 percentage points) and the data on microeconomic welfare recorded by the (2024) where food transport and core staple prices increased to historic levels. The work of Stella et al. (2025) is very supportive of this severe food security disruption. Their results indicated that fuel deregulation could serve as a direct regressive tax on the agrarian distribution networks and lead to the fast increase in food prices because of its effect on transport logistics. As the causal gap keeps growing to 2026, it is clear that this policy change resulted in a structural change in prices for consumers, rather than a temporary adjustment. This trend is echoed by historical simulations of welfare from the 2023. This outcome emphasises the high social costs of unmitigated neoliberal austerity policies, which involve reducing domestic price stability and public welfare in order to implement fiscal consolidation (Francis & Lucas, 2023). This counterfactual match is further supported by the fact that some countries – such as Angola and Ghana were expressly excluded from being active donors. They must make this adjustment because their own energy reforms would have affected the clean control baseline (IMF, 2023). The ratio of Mean Squared Prediction Error (MSPE) after over before the treatment is extremely high, which confirms that this is an extreme statistical outlier from the policy change. This is consistent with the structural break analysis done by Iliyasu et al. (2024). Eventually, the SCM counterfactual dispenses with the need for other theories of the underlying cause of this economic hardship. It offers clear evidence that premature market deregulation in a structurally fragile economy can affect long-term price stability, and consequently jeopardize the domestic social contract (Oluwaseun & Abiola, 2022).

5.4 Causal Policy Evaluation via Synthetic Control Method (SCM)

Fuel Subsidy Removal and the Regressing Economic Outcomes in Nigeria: The empirical underpinning of this study is based on the Synthetic Control Method (SCM) used to isolate and quantify the exact causal impact of the petroleum deregulation policy for the downstream sector in Nigeria in May 2023. The SCM framework provides an opportunity to examine the independent effects of the subsidy removal from the broader global macroeconomic shocks, including post-pandemic inflation, international supply-chain disruptions and global monetary tightening, by algorithmically generating a counterfactual Synthetic Nigeria using a carefully optimized donor pool of non-treated developing economies. The methodology thus allows for a clean causal analysis of the impact of the sudden removal of fuel subsidies on Nigeria's inflationary path, transportation costs, and overall welfare from 1999 to 2026. The treatment period under the SCM framework started from the removal of the Premium Motor Spirit (PMS) subsidy by the Federal Government of Nigeria and the complete deregulation of the downstream petroleum sector in May 2023 (Oladimeji & Umar, 2024). Before then, Nigeria's economy was under a significant state control of the petroleum prices with huge subsidy spending and price stabilization measures (Beedell, 2017). As such, the pre-treatment period from 1999 to 2022 is the base period in which domestic fuel prices were partially sheltered from the full effects of international market fluctuations by state intervention (Gunu & Kilishi, 2010).

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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Prices of PMS rose gradually from N20 per liter in 1999 to N30 in the year 2000 but then settled temporarily at N26 in 2002 in the early baseline phase (1999-2003). However, by 2003, prices had suddenly jumped to ₦42 per litre due to the high international prices of crude oil and fiscal constraints in the implementation of the early deregulation. This was an extended period of structural conflict between government-controlled pricing mechanisms and market realities from 2004 to 2014 (Olujobi & Irumekhai, 2024). In this period, PMS prices ranged from ₦50 to ₦75 per litre before climbing up to ₦97 to ₦141 per litre in 2014 when government became increasingly import dependent, the exchange rate became unstable, and the subsidy burden on public finances increased (Alozie, 2021; Olujobi & Irumekhai, 2024). The period from 2016-2022 marked a shift towards a partial deregulation shock and further deepening of market liberalization. Partially deregulated prices were increased to around ₦145 per liter by the market in 2016, due to the official deregulation of the prices, while poor foreign exchange situation and falling oil prices in 2017 pushed up PMS prices (Golub et al., 2023; Ogunjimi, 2020). Although temporary interventions stabilized prices near ₦165 in 2020 (Alozie, 2021), persistent currency depreciation and global oil-market volatility eventually forced prices upward again by late 2022 (Musa, 2024; Voituriez et al., 2023). Throughout this entire pre-treatment era, the SCM optimization algorithm assigned strategic weights to structurally comparable donor countries characterized by high fuel import dependence, fiscal vulnerabilities, and exposure to cost-push inflationary shocks. Consequently, Synthetic Nigeria successfully replicated the historical inflation, GDP growth, and exchange-rate trajectory of Real Nigeria before the 2023 policy intervention, thereby establishing a valid counterfactual baseline for causal estimation.

After the removal of the subsidies in May 2023, the paths of Real Nigeria and Synthetic Nigeria diverged in stark contrast, providing insight into the actual impact of the downstream petroleum subsidy removal. As soon as the subsidy was removed, the prices of PMS in Real Nigeria jumped from about ₦250 per liter to above ₦600 per liter (Ayoola, 2025; Felix, 2023). In 2024, the inflationary spiral got worse as exchange rate depreciated, import costs increased, and domestic petroleum pricing was fully liberalized, ranging from ₦1,000 to ₦1,250 per litre (Ayenigba, 2025; Lawan et al., 2026). The prices of Petrol, Diesel and LPG were between N1, 000 and N1, 490 per litre by 2025 and early 2026 which was the highest ever recorded price of fuels in the economic history of Nigeria (Ayenigba, 2025). By contrast, the counter-factual (Synthetic Nigeria) scenario, in which the subsidies were not discontinued, continued to have a much less erratic and disruptive price path. This divergence had tremendous ramifications for the Nigerian economy as reported in Table 7 of the SCM results indicates that transportation, logistics and domestic production systems are heavily reliant on the transportation networks powered by PMS. Fuel prices rose significantly, leading to rapid growth in transportation prices and inflationary pressures throughout food markets, household consumption, and overall welfare. Nigeria's fuel subsidy removal witnessed a sharp surge in transportation fares, both local and international, and prices of basic food commodities like bread, onions and tomatoes. The findings of the simulation corroborates earlier reported by Ajuwon & Abiodun (2026), Kayode & Idera (2025), Ozili & Obiora (2023) and Yahaya (2026). These indicators of the microeconomic effects of the energy shock imply that the withdrawal of energy subsidies quickly led to a significant decline in the purchasing power of households and real energy wages. Infrastructure deterioration and the increasing prices of food and transportation were particularly harsh on the poorest households, as they saw a squeeze on the disposable income. The SCM framework therefore simulates the post-2023 period as one of major deterioration of welfare, mainly due to cost-push inflationary pressures, and not to the increase of productive economic efficiency.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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Table 7: Micro-Welfare Quantifications of the Causal Treatment Effect

Commodity / Service	Pre-Treatment Price (Real/Synthetic Match)	Post-Treatment Price (Real Treated Path)	Net Causal Price Inflation (Δ)
Short-Distance Transport Fare	₦2,000	₦6,000+	+200.0%
Long-Distance Transport Fare	₦3,000	₦8,000	+166.7%
Family-Size Loaf of Bread	₦750	₦1,200	+60.0%
Standard Bucket of Onions	₦1,000	₦3,000	+200.0%
Standard Bucket of Tomatoes	₦2,000	₦4,000	+100.0%

The SCM evaluation also sheds light on a significant institutional conflict between the macro-fiscal goals of IFIs and Nigeria's social norms. International financial institutions (IFIs) like the International Monetary Fund (IMF) and the World Bank have consistently stated that Nigeria's huge spending on fuel subsidies from 2010 to 2022 made Nigeria's budget unsustainable, enabled corruption, fueled fuel smuggling, and limited public investment on health, education, and infrastructure (Nwozor et al., 2020; Sambo & Sule, 2023). In this macroeconomic context, the removal of subsidies was considered to be a structural adjustment that could reduce the inefficiency of the fiscal system and allocate public funds more efficiently to productive development goals. The social resistance to the practical effects of the reform, however, was significant owing to an inadequate social safety net and institutionalized welfare measures in the area of energy subsidy removal (Akpughe & Raphael, 2025; Ifeyinwa et al., 2025). The deteriorating welfare conditions arising from the increase in the prices of fuel and inflation triggered nationwide protests, demonstration and strike threats by organized labour groups like Nigeria Labour Congress and Trade Union Congress (Ikenga & Oluka, 2023). While the economic activities were not fully paralyzed by the social unrest, the continuous unrest in the country highlighted the fact that, in a structurally vulnerable economy, no significant economic restructuring could happen without proper compensating measures.

Over time, the Synthetic Control Method yields compelling empirical evidence that the downstream petroleum sector deregulation increased the fiscal consolidation and decreased the subsidy expenditure, but also shifted the adjustment costs directly on the Nigerian households. The SCM clearly shows that when the government withdrew subsidies, it led to a permanent rise in food poverty, transportation costs and headline inflation in the Nigerian economy. The results therefore indicate that when there is no adequate local refining ability and social protection structures in an import reliant economy, the elimination of the corresponding price stabilization mechanism can lead to significant welfare losses and persistent macroeconomic instability. Therefore, the study finds that optimizing the fiscal policy with the sudden deregulation of the market economy could have significant social and human consequences if applied in developing economies that are structurally weak like Nigeria.

Exchange Rate Liberalization and Unification: This section operationalizes the Synthetic Control Method (SCM) to isolate and assess the causal macroeconomic effects of Nigeria's historic exchange rate regimes, including the foreign exchange unification policy of June 2023. The SCM introduces a simulated optimized counter factual (Synthetic Nigeria) that allows one to isolate the net treatment effect of currency liberalization from other external shocks that might have befallen Nigeria, and elucidates the impact of structural adjustment on a robust agrarian economy on becoming an import-dependent single petro economy. The Dollar-to-Naira exchange rate (EXRt) is the variable of interest in the SCM Pre-Intervention Trajectory and the Mono-Petro Structural Break. The pre-intervention historical time period is used to build the counterfactual baseline through the use of structural weights (W*) provided by the algorithm. In 1972, as Nigeria's economy was structurally diversified, with strong agricultural exports like cocoa, ground nut, palm

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

oil and rubber, the exchange rate of the Naira to USD was very high, and the Naira was of high structural strength, exchanging at around ₦0.65 to $1.00. In this non-indebted period, the domestic economy was directly insulated from the external currency shocks by the existence of the fixed exchange rate regime according to Sa'ad et al. (2023). But the commercialization of crude oil in the 1970s (Ogundipe et al., 2014) and the introduction of the SAP in the 1980s (Nelson, 2025) completely upset this baseline. Under the rationale that a weak currency would stimulate non-oil export competitiveness, SAP adopted devaluation of the exchange rate as the policy instrument it used to achieve the goal of stimulating non-oil export competitiveness (Dauda & Iwegbu, 2022). Rather, it created a heavy reliance on the US Dollar as the de facto global currencies for trading oil (Eichengreen et al., 2014; Ajala et al., 2021). By 2002, this structural distortion had been fully established, with the oil industry contributing 98% of Nigeria's foreign exchange earnings and the years have seen the agricultural sector completely marginalized and the country become a net importer of food (Nweze & Edame, 2016; Diao & Thurlow, 2008). The results reflect the reality of this steady and gradual depreciation of the currency over a period of 22 years, from 2000 to 2022, by pairing up the real economic history with a weighted average of the donor countries. It dropped from the base rate of N85.95 in 2000 to N99-N106 in 2001, and further weakened to N127-N136 by 2005, even as the oil revenue increased, while the country's reliance on imports continued to grow (Moses et al., 2020). The brief stabilization window (₦115-₦131) that followed was violently ended by the 2009 global financial crisis and a sharp depreciation was forced into a ₦145-₦171 trading band (Moses et al., 2020). The Commodity Collapse and Recession (2010-2017) was caused by structural manufacturing decreases, the currency fell to ₦148-₦165 in 2013 and dropped to ₦170-₦199 in 2014 due to the drop in global crude prices(Moses et al., 2020). The next recession (2015-2017) saw currency trade in a volatile range of ₦199 to ₦400 as the capital controls were not rigidly implemented. In 2018, the official rate was stabilized close to the ₦360 mark by aggressive Central Bank interventions during the Capital Flight Window (2018-2022). However, as inflation continued to pick up pace and external resources dwindled, the currency dropped to trade within a range of ₦365-₦600 by the end of 2022. In this 22-year pre-treatment period, however, Synthetic Nigeria has an unblemished simulated fit with Real Nigeria, suggesting that the counterfactual is an important determinant of common global oil shocks and emerging-market volatility. The Federal Government made the definitive policy move in June 2023, by fully liberalizing and unifying the foreign exchange windows (Gold & Yusuf, 2025). The SCM models this event as a sharp, historic divergence between the real treated path and the synthetic baseline. The table below (Table 8) shows that Real Nigeria had a very steep upward trend compared to a controlled exchange rate, where the depreciation rates would have been moderate until about 2026.The table below (Table 8) shows that a managed exchange rate would have kept the depreciation curve steady and moderate, whereas Real Nigeria had a very steep upward trend. The exchange rate also broke the historical trend, rising to ₦1200 for the year 2024, hovering around ₦1250 in 2025 and posting a high degree of volatility after liberalization of the exchange rate, ranging from ₦1450 to ₦1600 by 2026. This huge mathematical difference completely captures the unadulterated retributive cost of liberalization policy. With respect to the Transmission Mechanism to Welfare and Cost of Living, the SCM causal evaluation results suggest that exchange rate unification in a mono-petro economy with neglected domestic production is an immediate push factor of domestic prices. Furthermore, the nation's oil production capacity was paralysed by poor governance, vandalism of pipelines and resource control issues, making its foreign exchange earnings insufficient to sustain the floated currency (Akpomera, 2024; Global Peace and Security, 2022). This in turn led to a very significant direct impact on the landing price of imported fuel and other essential

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

commodities through the direct impact of the causal currency shock. This currency devaluation became a day-to-day struggle for the Nigerian people who were net food importers. The SCM counterfactual clearly shows that the stagflationary spirals of 2023-2026 were not inevitable and natural outcomes of the global economy, but a direct and causal result of floating a currency within a structurally broken, import-dependent system.

Table 8: The 2023 Unification Treatment and Causal Divergence (2023-2026)

Year	Synthetic Nigeria EXR (Counterfactual Projection)	Real Nigeria EXR (Post-Liberalization Path)	Isolated Causal Treatment Effect (τ)
2022	₦580.00	₦600.00	+₦20.00 (Baseline Sync)
2023	₦620.00	₦1,000.00 – ₦1,200.00	+₦480.00 to +₦580.00
2024	₦650.00	₦1,200.00	+₦550.00
2025	₦680.00	₦1,250.00	+₦570.00
2026	₦710.00	₦1,450.00 – ₦1,600.00	+₦740.00 to +₦890.00

Policy Implications of the Study

The stark asymmetric pass-through of fuel prices uncovered by the NARDL model suggests that policy makers should not rely on the notion that market forces will naturally lead to a stabilization of consumer prices following a subsidy removal. As future price changes are downwardly sticky, they cannot be taken for granted, but can only happen when regulatory measures are implemented, which will help prevent unfair pricing and speculative hoarding by market players. Firstly the focus of the policy should move from mere fiscal deficit management to a speedy reconstruction of domestic refining capacity, which will enable the country to be less dependent on imported fuel. This will reduce the landing cost of petroleum products and remove the need for foreign exchange to be used for fuel imports as the local refineries will be rebuilt.

Moreover, the close linkage between the exchange rate and retail pump price makes the stabilization of the Naira very imperative for the effective control of the cost-push inflation in the country. The Central Bank of Nigeria needs to coordinate with fiscal authorities to slow down the rate of interest hikes as these have little effect on supply-side cost shocks (Knicker et al., 2024). Rather, the interest of monetary policy should be given to specific foreign exchange liquidity support to critical sectors to decrease the imported cost spiral. The government must invest in targeted transport subsidies for agricultural logistics to offset the dramatic rise in the food poverty index indicated by the SCM model. Raising public transportation investment in compressed natural gas (CNG) infrastructure can help break the link between food distribution expenses and erratic prices for petroleum-based fuel. The size of seasonal storage facilities should be increased close to the main agricultural centres to help reduce retail price fluctuations and smoothen food supply shocks. Future fiscal changes should be phased and accompanied by predetermined social safety nets instead of sudden changes. Cash transfer programs should be scaled up and made digital to make the process transparent before the eventual elimination of cash transfer subsidies. Policy makers need to set up explicit institutional channels to allocate saved subsidy funds directly towards public infrastructure, healthcare and education. Monitoring and reporting the spending of such saved money will help to restore the public trust and reinforce the social contract within the country. Medium-term solutions include the encouragement of alternative energy sources, such as solar energy, to lessen the need for small gasoline generators by small businesses. Tax incentives for imported renewable energy will reduce the costs for micro-businesses and the pressure on prices. Regional anti-smuggling enforcement also needs to be strengthened to make sure that market interventions don't fail due to leaks in the region. Lastly, the Federal Executive Council of Nigeria should closely watch the transmission of shocks over

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 59 Issue: 03:2026
DOI: 10.5281/zenodo.21027575

time, so as to optimize policy instruments accordingly. Finally, these coordinated interventions can contribute to Nigeria's shift from a fragile import-dependent economy to a resilient, self-reliant economy based on production.

Contributions to Knowledge

The empirical contribution of this study brings together two types of research methods: long-run asymmetric time-series models and causal counterfactual simulation, to assess the impact of macroeconomic policy in a developing economy. The study provides a methodological framework that pools the Synthetic Control Method and the NARDL and TVP-SVAR approaches. In other words, this research advances the empirical literature by combining long-run asymmetric time-series models with causal counterfactual algorithms to evaluate macroeconomic policy in a developing country. By incorporating the Synthetic Control Method alongside NARDL and TVP-SVAR frameworks, the research addresses a methodological gap in isolating single-country policy shocks. This study fills in a methodological gap that has been missing to date in the literature by integrating the Synthetic Control Method with the NARDL and TVP-SVAR frameworks. Unlike the traditional linear model, the study demonstrates that the effect of positive and negative shocks to energy prices on the macroeconomy of Nigeria is not the same. It offers empirical evidence of the downside price stickiness in the downstream petroleum sector and how cost shocks filter through over time. In addition, a time-varying parameter model provides deeper insights into the evolution of inflation transmission through various historical policy periods. The results demonstrate a definite structural change, thus confirming that the economy has become more vulnerable to fuel price increases because of the reduction in domestic refining capacity. By building up a 20-country donor pool to be used as a valid counterfactual baseline for Nigeria, this research provides a valuable contribution. The causal estimates are not contaminated by parallel reforms or external shocks in the region, which can only be avoided by careful filtering of this donor pool.

The study brings up to date the concept of Dependency Theory, by demonstrating that a lack of domestic processing infrastructure renders a resource-rich nation vulnerable to external pressures on cost. It explains how a cycle of high fuel prices and exchange rate devaluation can keep domestic inflation going. The dissertation also offers a precise quantification of the loss of the social contract after sudden cutbacks in benefits. The study precisely estimates the domestic cost of reform by isolating out the effect of the specific policy impact from the global inflation that happened after the pandemic.

The study provides new knowledge on the transmission of energy cost shocks via food distribution networks to change the food poverty index. This work offers a very comprehensive, multi-decade series from which the long-term effects of structural adjustments can be traced since 1986 until 2026. It refutes the conventional economic views of the demand side on inflation and demonstrates that cost-push factors dominate the inflation picture in Nigeria. The report also provides a blueprint of how to appraise large scale economic change in other resource-dependent developing countries.

The study also connects the macro-econometric modeling approach with the micro-level welfare analysis approach by reflecting structural shocks in poverty measures at the household level. Furthermore, endogenous break tests validate that the major policy changes are structural in nature, not simply a short-term impact. The methodology used in this comprehensive analysis can be used by future researchers to validate policy evaluation. Finally, this study offers an analytical framework that alters the scholarship surrounding the timing and social price of neoliberal economic reform.

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DOI: 10.5281/zenodo.21027575

6. CONCLUSION

The empirical evidence in this study offers a conclusive picture of the macroeconomic impact of the fuel subsidy removal in Nigeria in May 2023. However, the unit root and co-integration tests indicate that fuel pricing and the exchange rate and inflation appear to share a common long run path in spite of the presence of significant structural breaks. The NARDL model validates the structural asymmetry which implies that price hikes lead to sharp increases in inflation, whereas price reductions have modest effects. The price stickiness in the down direction underscores structural distortions that enable merchants to keep prices high when there is a fall in input prices. This also reflects an increase in sensitivity in the TVP-SVAR results, with the short-term effects of fuel shocks having been significantly greater since 1986 until 2026. This increased sensitivity is a direct result of the reduction of the country's refining capacity, and consequently the sensitivity to imported fuel costs. The variance decomposition analysis results validate the fact that fuel price shocks are the main drivers of short-term inflation volatility, with exchange rate depreciation the major determinant of long-term inflation. This interaction establishes a positive feedback loop, which continuously raises the landing price of refined petroleum products. The Synthetic Control Method offers unambiguous causal evidence, as the Real Nigeria and the counterfactual base lines diverge heavily from one another right after the policy intervention. The net impact of the subsidy removal on headline inflation was 15.50 percentage points at the end of 2024, illustrated by the SCM model. Likewise, the food poverty index reveals a net causal distortion of 17.90 percentage points, with a focus on the influence on key consumer goods. This divergence continues through 2026, suggesting that the policy change led to a lasting structural change, as opposed to an immediate spike in price. The findings are consistent with Dependency Theory's main tenets, highlighting the structural fragility of a peripheral, oil-exporting nation. A quick decline in the purchasing power of households also confirms Social Contract Theory, in which the social costs of the absence of fiscal cushions without safety nets are shown. The findings, however, are unique to Nigeria, and it is clear that they are the result of the domestic policy decisions made in 2023 in Nigeria, a fact that is confirmed by placebo testing. The results confirm that a rise in Nigeria's inflation rate was not as a result of the excess demand side but at the supply side. Thus, simply using monetary tightening via interest rate increases is not enough to solve a structural cost restructuring of this magnitude. The study demonstrates that price instability and increased poverty was a significant cost of fiscal deficit reduction. This result highlights the dangers of trying to pursue rapid neoliberal economic reforms in country economies where the underlying domestic supply side is weak. It is found from this study that long-term stability can only be achieved by developing capacity building for domestic production and coordinating fiscal and monetary policies for protecting the welfare of the people.

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Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
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