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Simulating the Inflationary Effects of Fuel Subsidy Removal in Nigeria: Evidence From a Novel Approach

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This study simulates the effect of fuel subsidy removal on different categories of inflation in Nigeria using the novel dynamic simulated autoregressive distributed lag framework. Findings revealed heterogeneity in the inflationary effect of an increase in premium motor spirit price across locations, and that the recent fuel subsidy removal in Nigeria will have long-lasting negative inflationary effects.

I. Introduction

Nigeria is the foremost oil-rich country in Africa with a crude oil reserve of about 37.1 billion barrels and a daily crude oil production of about 1.5-2 million barrels (Raifu & Oshota, 2023). The country's crude oil export is in high demand due to its light and low sulphur content. Thus, Nigeria has become heavily reliant on this primary product, whose price is largely influenced by market forces and major world crude oil producers. As such, the Nigerian economy often experiences cyclical movements when oil price changes. Specifically, oil price changes have dual effects on the Nigerian economy – an avenue for more/less foreign exchange earnings and an increase/decrease in subsidy payments (Abatcha, 2021; Raifu et al., 2020).

Nigeria's limited local refining capability has made her a net importer of refined crude oil products due to the country's four dilapidated refineries (Ogunjimi, 2020). Thus, an increase in the global crude oil price is often associated with an increase in premium motor spirit (PMS) price. To cushion the effect of such price increases, the Nigerian government subsidises the PMS price to aid affordability. Historical evidence shows that the government has been subsidising the price of petrol since 1973 (McCulloch et al., 2021). Petrol subsidies are unsustainable and need to be terminated because of recurring fiscal crises and general socioeconomic problems engulfing the country. Despite this reality, fuel subsidy removal appears unachievable for successive Nigerian governments due to the threats of industrial actions and their perceived negative impact on the economy (Nnadozie et al., 2022). However, the current president, in his inaugural speech on May 29th 2023, declared that "petrol subsidy is gone." The following day, PMS price soared from N238.11 to N557 per litre and to N617 a month later with slight variations across the country (Central Bank of Nigeria, 2023).

The removal of the PMS subsidy has caused a substantial surge in commuting costs (of nearly 300%) between different locations and exacerbated economic challenges among residents across all social strata. This has exerted a direct impact on the cost of essential food commodities within the national markets. With a double-digit inflation rate of 22.79%, an exchange rate (Naira to US$) surpassing the N700/1$ threshold, and a high debt profile (CBN, 2023), the Nigerian economy could further deteriorate. The confluence of a liberalized exchange rate regime and heightened importation costs of petroleum products can exacerbate the inflationary pressures through increased petroleum product landing costs. According to the World Bank's half-year report on Nigeria's economy, if the current situation persists, an additional 4 million citizens will most likely be added to the 133 million citizens enmeshed in multidimensional poverty (National Bureau of Statistics, 2022).[1]

Against this backdrop, the present study simulated the effect of the removal of petrol subsidies, as evidenced by increasing PMS prices, on Nigeria's inflation trajectory. We hypothesized that the removal of the petroleum subsidy will not generate inflationary pressures. We tested this hypothesis using the innovative dynamic simulated autoregressive distributed lag (DS-ARDL) framework. The framework shed light on the sophisticated interplay between these two variables in the short and long run. Furthermore, we dichotomised the effect of subsidy removal on total, rural, and urban inflation to gain further insights. The rest

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1 https://www.worldbank.org/en/news/press-release/2023/06/27/nigeria-can-seize-the-opportunity-to-realize-its-growth-potential

of the study is structured as follows: section II presents the methodology and data sources; the results are presented in section III, and the conclusion is presented in section IV.

II. Methodology and Data Sources

To simulate the impact of subsidy removal on inflation in Nigeria, this study employed a DS-ARDL model. After the announcement of subsidy removal, the PMS price surged from N238.11 to N557 per litre, representing a 134% increase. We used this percentage to simulate the impact on inflation rates (total, rural, and urban). In our model, we also included control variables such as money supply and exchange rate, which are theoretically linked to inflation, according to the quantity theory of money and the monetary approach to exchange rate. Following Sarkodie and Owusu's (2020) work, the DS-ARDL model that captures the effect of subsidy removal on inflation is specified as follows:

$$\begin{aligned} lncpi_t = {} & \alpha_0 lncpi_{t-1} + \alpha_1 lnpms_t + \alpha_2 lnpms_{t-1} \\ & + \alpha_3 lnms_t + \alpha_4 lnms_{t-1} + \alpha_5 lnextr_t \\ & + \alpha_1 lnextr_{t-1} + \varepsilon_t \end{aligned} \quad (1)$$

Where cpi represents the consumer price index capturing the inflation rate; we considered three variations of inflation: total, rural, and urban inflation; rural and urban inflation differentiate the impact of subsidy removal on the welfare of rural and urban populations; pms denotes the price of petrol; ms stands for money supply; $extr$ is the exchange rate; and ε is the error term. A priori, we expected that petrol price, money supply, and exchange rate would have a positive effect on inflation. The data of these variables, covering 1995M01-2023M06, were sourced from the NBS and the CBN.

To implement equation 1, we adhered to Sarkodie and Owusu's (2020) methodology. Firstly, we conducted a unit root test using the Phillips-Perron method. We, then, employed Pesaran et al. (2001) standard ARDL approach to confirm the presence of cointegration among the variables. Subsequently, we performed post-estimation diagnostics to validate the ARDL model before proceeding to the DS-ARDL.[2]

III. Empirical Findings

A. Descriptive Statistics

Table 1 shows that the PMS price averaged N75.78 and has evolved from N11 to N545.83, with the maximum value showing the PMS price after the removal of the fuel subsidy. A similar pattern was observed for the various types of inflation, whose minimum and maximum values had wide disparities. In line with the quantity theory of money, the evolution of money supply suggests that the rising inflation rate in Nigeria could be attributed to the rising money supply, which averaged N5.66 million. In the same vein, the range of exchange rates shows that the Nigerian domestic currency has experienced episodes of depreciation or devaluation over time. This has implications for inflation. To control for spurious results, we evaluated the stationarity properties of each variable using the Phillip Perron method. The results show that the variables are integrated of order one (see the last two columns of Table 1).

B. ARDL Results

Having established the presence of a long-run relationship among our variables of interest, we estimated the short-run and long-run ARDL models and presented their results in Table 2. The long-run results show that an increase in PMS price will worsen total, rural, and urban inflation. The magnitude of impact differs, with the rural areas being more badly hit by rising price levels. The relatively higher vulnerability of rural dwellers to high inflation resulting from the rising PMS price, following fuel subsidy removal, could be due to their lower income levels and limited access to financial services. Given these limitations, their real income and purchasing power reduced drastically, making it more challenging for them to afford basic goods and services. Thus, rural residents could plunge further into abject poverty. The results of the short-run model also show that increasing PMS prices worsens inflation in the rural and urban areas of Nigeria, but the impact is more pronounced in urban communities. This validates the findings of extant studies like those of Abatcha (2021) and Nnadozie et al. (2022). Sadly, the speed of adjustment to long-run equilibrium, shown by the error correction term, is very slow across the three estimated models, as it could take approximately 20 months (24, 20, and 17 months for total, rural, and urban inflation respectively) for inflation to revert to its initial equilibrium. Thus, the PMS is indispensable to the Nigerian economy, and the interconnections of its price impacts macroeconomic performance in Nigeria (Aminu & Ogunjimi, 2019). The estimates of the control variables align with theoretical expectations but have heterogeneous inflationary effects across the rural-urban dichotomy. For example, an increase in money supply and exchange rate trigger inflationary pressures at different degrees in the rural and urban areas.

C. DS-ARDL Results

To determine the inflationary effects of simulated PMS price change, we simulated the 134% change in the PMS price after the removal of the fuel subsidy. The simulation was carried out on total, urban, and rural inflation. The results are displayed in Figure 1, and the estimates are shown in Table 3 (see Appendix). Figure 1 shows that 134% shock in PMS price has a similar impact on urban, rural, and total inflation. Specifically, Figure 1 reveals that the shock to PMS price at time t=10 will instigate an instant increase in inflation, which will continue over the next 20 periods (20 months) in both the rural and urban areas. The increase in rural, urban, and total inflation, in response to the shock

2 The diagnostic test results are not presented here but they are available on demand.

Table 1. Descriptive Statistics and Unit Root Test

Variable	Obs.	Mean	Std. Dev.	Min	Max	Phillip Perron (Level)	Phillip Perron (First Difference)
Total Inflation	342	140.856	127.394	14.36	559.1	-0.651	-12.678***
Rural Inflation	342	139.762	123.751	14.75	537.733	-0.149	-14.194***
Urban Inflation	342	141.865	132.027	13.7	583.907	-0.435	-16.507***
PMS Price	342	75.776	63.856	11	545.83	0.387	-18.367***
Money Supply	342	5663924.2	5687290.1	158150	24000000	-1.384	-22.917***
Exchange Rate	342	184.589	107.028	75.34	607.25	1.769	-9.692***

Note: Table 1 shows the results of descriptive statistics and unit root tests of relevant variables. *** denote significance at 1%.

to PMS price, will result in a new equilibrium prediction for inflation, as it would increase inflation. This will reduce purchasing power in rural and urban areas in Nigeria and could exacerbate existing macroeconomic challenges. Overall, the removal of the fuel subsidy cum high PMS prices will have a lasting and increasing but negative impact on rural, urban, and total inflation rates in Nigeria.

IV. Conclusion

This study underscored the inflationary effects of PMS price and simulated the extent to which PMS price will influence inflation in Nigeria. Findings showed that PMS price largely determines the direction of inflation in Nigeria, although there is a slight difference in the inflationary effect in rural and urban areas. Further analysis revealed the long-lasting inflationary effect of the recent fuel subsidy, highlighting the need to deploy strategies to mitigate the rising inflationary pressures in Nigeria. Particularly, the Nigerian government should reinvest savings from subsidy removal in revamping the country's refineries. The country should ensure the refinery with the least cost is fully operational before revamping the others. More so, targeted cash transfers to vulnerable areas, particularly those in rural communities, should be deployed to counterbalance inflationary pressures and mitigate the immediate impact of oil price change on living costs.

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Table 2. ARDL Estimation

Variables	Total Inflation	Rural Inflation	Urban Inflation
Long-Run Model			
lpms(-1)	0.430***	0.426***	0.246***
lbm(-1)	0.303***	0.290***	0.143***
lextrate(-1)	-0.330**	-0.289**	0.212***
tcpid(-1)	-3.394***		
rucpid(-1)		-3.204***	
urcpid(-1)			-1.838***
dlcpi(-1)	1.000***		
dlcpi_ru(-1)		0.971***	
dlcpi_ur(-1)			0.730***
dlpms(-1)	-0.322		
dlpms_ru(-1)		-0.334	
dlpms_ur(-1)			-0.284***
Short-Run Model			
Δlpms	0.018***	0.021***	0.045***
Δlpms(-1)			0.069***
Δlbm	0.012***	0.015***	0.008***
Δlextrate	-0.014**	-0.015*	0.012***
Δtcpid	-0.140***		
Δrucpid		-0.161***	
Δurcpid			-3.693***
Δurcpid(-1)			0.257***
Δdlcpi	0.041***		
Δdlcpi_ru		0.049***	
Δdlcpi_ur			0.993***
Δdlpms	-0.013		
Δdlpms_ru		-0.017	
Δdlpms_ur			-0.048***
Δdlpms_ur(-1)			-0.070***
Δlcpi(-1)	0.290***		
Δlcpi_ru(-1)		0.205***	
Adj	-0.041***	-0.050***	-0.058***

Note: Table 2 reports the ARDL results of the inflationary effects of oil price changes in Nigeria in rural and urban areas. Note: Adj denotes the speed of adjustment. cpi, cpi_ru, cpi_ur, pms, bm and extrate represent total inflation, rural inflation, urban inflation, price of PMS, broad money and exchange rate, respectively. All variables are in logarithm form. ***, ** and * represent 1%, 5% and 10% levels of significance.

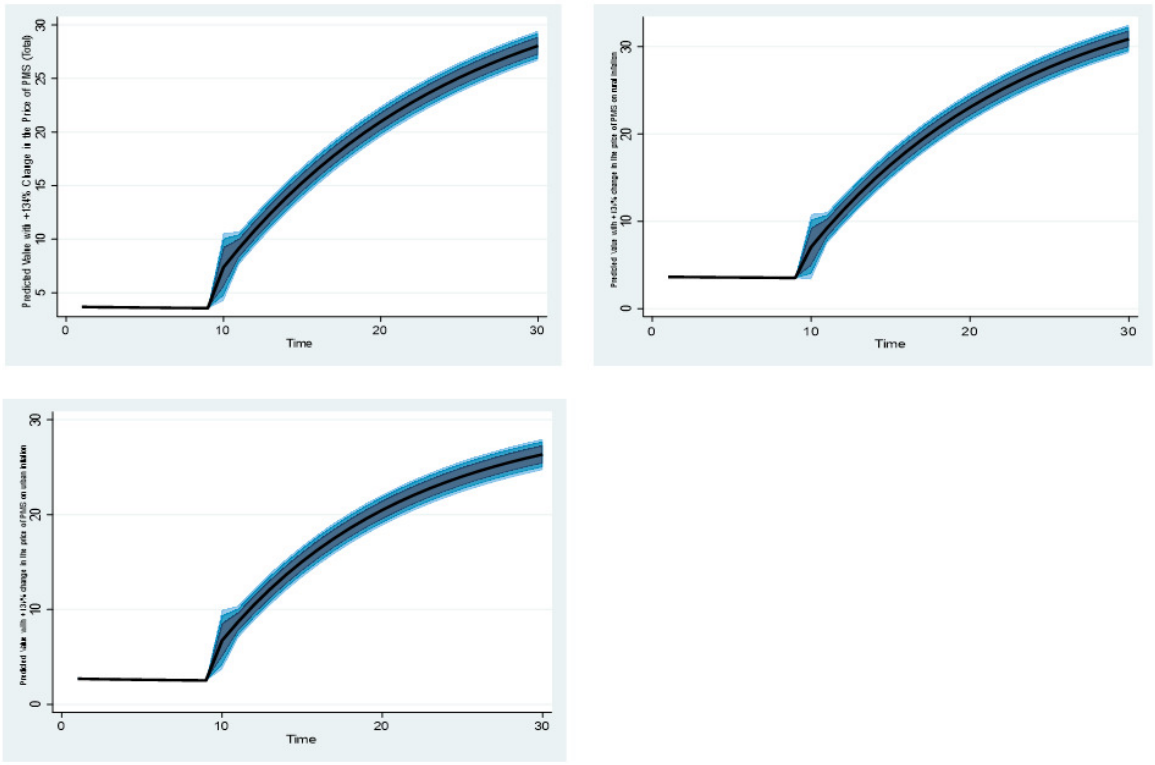

Figure 1. Simulation of 134% Increase in PMS Price on Total, Rural and Urban Inflation

Note: This figure plots the counterfactual effect of a 134% change in the PMS price on total, rural and urban inflation, respectively.

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APPENDIX

Table A1. DS-ARDL Estimation

Variables	Total Inflation	Rural Inflation	Urban Inflation
Long-Run Model			
lpms(-1)	0.015**	0.018***	0.017***
lbm(-1)	0.021***	0.022***	0.016***
lextrate(-1)	0.005	0.005	0.024***
tcpid(-1)	-0.125***		
rucpid(-1)		-0.134**	
urcpid(-1)			-0.126***
dlcpi(-1)	0.045***		
dlcpi_ru(-1)		0.050***	
dlcpi_ur(-1)			0.051***
dlpms(-1)	-0.022*		
dlpms_ru(-1)		-0.025*	
dlpms_ur(-1)			-0.021***
Constant	-0.107***	-0.104**	-0.081**
Short-Run Model			
Δlpms	0.028**	0.026*	0.031**
Δlbm	0.016	0.016	0.010
Δlextrate	0.007	0.009	-0.019
Δtcpid	-3.703**		
Δrucpid		-3.499	
Δurcpid			-3.720***
Δdlcpi	0.760**		
Δdlcpi_ru		0.716	
Δdlcpi_ur			0.982***
Δdlpms	-0.030		
Δdlpms_ru		-0.028	
Δdlpms_ur			-0.031**
Adj	-0.063***	-0.069***	-0.082***

Table 3 reports the DS-ARDL results on the inflationary effects of the 134% increase in PMS price after subsidy removal in Nigeria. Note: Adj denotes the speed of adjustment. cpi, cpi_ru, cpi_ur, pms, bm and extrate represent total inflation, rural inflation, urban inflation, price of PMS, broad money and exchange rate, respectively. All variables are in logarithm form. ***, ** and * represent 1%, 5% and 10% levels of significance.