ON THE EFFECT OF CONSUMER PRICE INDEX INFLATION ON FOOD SECURITY AND PUBLIC HEALTH OUTCOMES IN NIGERIA: A TIME SERIES APPROACH

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Abstract
Persistent inflation remains a major macroeconomic challenge in Nigeria, with rising consumer prices—particularly food prices—posing serious threats to food security and public health outcomes. This study investigates the dynamic behavior of Nigeria's Consumer Price Index (CPI) and examines its implications for food security and public health using a time series approach. Monthly CPI data were analyzed within the Box–Jenkins framework, employing Autoregressive Integrated Moving Average (ARIMA) models. Stationarity was assessed using Augmented Dickey–Fuller (ADF) and KPSS tests, while model adequacy was evaluated through diagnostic checks including residual autocorrelation, heteroscedasticity, and normality tests. The results indicate that the CPI series is integrated of order one, I(1), and the ARIMA(3,1,2) model provides the best fit based on information criteria. Forecasts from the selected model suggest a mild deceleration in CPI inflation over the forecast horizon, although uncertainty widens over time. From a food security and public health perspective, persistent CPI inflation—especially food inflation—erodes household purchasing power, reduces dietary quality, and heightens risks of malnutrition, maternal and child morbidity, and social vulnerability. The study underscores that inflation is not merely a macroeconomic indicator but a critical determinant of population health and human security. It recommends strengthened inflation monitoring, improved agricultural productivity, and integrated economic–health policy responses to mitigate the adverse welfare effects of rising prices in Nigeria.

Keywords: Inflation, Consumer Price Index, Food Security, Public Health, Time Series

Introduction

Inflation, defined as the persistent rise in the general price level of goods and services, is a major macroeconomic concern in both developed and developing nations. In Nigeria, inflation is commonly measured by the Consumer Price Index (CPI), which tracks the prices of a fixed basket of goods and services consumed by households (Hamza, 2021; Ibrahim *et al*, 2022). Over the past decade, Nigeria has faced persistent double-digit inflation, with food inflation consistently surpassing headline inflation. For example, in 2024, while headline inflation stood at 32.2%, food inflation reached 37.5%, largely due to subsidy removal and exchange rate depreciation (Awogbemi *et al,* 2025).

The link between inflation and public health outcomes is increasingly recognized. Rising food prices erode household purchasing power, reduce access to nutritious diets, and exacerbate malnutrition, maternal health risks, and food insecurity (Ajayi & Bankole, 2025). The Food and Agriculture Organization (FAO) estimates that nearly 25 million Nigerians face acute food insecurity, driven by inflation, conflict, and infrastructural deficits (FAO, 2023). These conditions worsen public health outcomes, increase poverty, and contribute to national insecurity.

From a statistical perspective, modeling and forecasting CPI is vital for understanding future inflationary trends and their consequences. Time series methods such as Autoregressive Integrated Moving Average (ARIMA), Seasonal ARIMA (SARIMA), and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) have been widely applied in Nigeria and other developing economies to forecast CPI and inflation trends (Nadum *et al*, 2020; Wiri *et al*, 2021; Olagunju *et al*, 2025). However, fewer studies have explicitly linked CPI forecasting to food security and public health outcomes, leaving a significant research gap. This study therefore seeks to use time series modeling to forecast Nigeria's CPI and examines its implications for food security and public health.

Nigeria's inflationary environment poses severe challenges to economic stability, food access, and public health. Despite various monetary and fiscal interventions, inflation has remained stubbornly high, particularly in the food sector. The removal of subsidies, exchange rate fluctuations, and insecurity in agricultural zones have further heightened food inflation.

While numerous studies have applied time series models to forecast inflation and CPI (Hamza, 2021; Ibrahim *et al*, 2022;), the consequences of rising CPI are most acutely felt in nutritional insecurity, maternal and child health risks, and increased burden on health systems. Moreover, persistent inflation has been linked to insecurity through food riots, farmer–herder conflicts, and youth vulnerability to recruitment by insurgent groups.

Thus, the problem this study addresses is twofold: the lack of comprehensive statistical modeling of Nigeria's CPI that accounts for its structural breaks and volatility, and, the absence of a statistical framework that connects CPI inflation forecasts with public health and food security outcomes. It also contributes to academic, policy, and practical knowledge in several ways. It is expected to expand the application of time series analysis in linking CPI forecasts to public health outcomes, addressing a gap in statistical literature. It is also expected to provide evidence-based insights to guide monetary policy, agricultural reforms, and public health interventions aimed at stabilizing prices and protecting vulnerable groups. The study is also expected to highlight the role of inflation as a determinant of malnutrition, maternal and child health, and mental health, emphasizing the need for integrated responses and to establish a statistical basis for understanding how inflation-driven food insecurity contributes to social unrest and national insecurity.

2. Literature Review

Inflation is commonly conceptualized as a sustained rise in the general price level of goods and services, leading to reduced purchasing power. The CPI serves as the most widely used measure of inflation, as it captures household expenditures on food, housing, transportation, and other essentials (Awogbemi *et al,* 2025).

Food security, as defined by FAO (1996), exists when all people have access to sufficient, safe, and nutritious food to meet their dietary needs. Rising food inflation undermines this access, particularly in Nigeria where food accounts for more than 50% of household expenditure. Public health outcomes are therefore strongly tied to food affordability, with inflation directly influencing malnutrition, maternal health, and child mortality.

From the Monetarist Perspective, inflation results from excessive money supply relative to output. Friedman (2024) argued that "inflation is always and everywhere a monetary phenomenon." This view emphasizes monetary policy in inflation control. Whereas, Structuralists sees inflation arising from structural bottlenecks such as food supply shocks, foreign exchange shortages, and conflicts. In Nigeria, structural factors such as farmer–herder clashes, climate shocks, and infrastructural deficits reinforce inflationary pressures (Egbule & Okonta, 2024; Okopi *et al*, 2024; Adamgbe *et al*, 2025). Therefore, both perspectives are relevant, as monetary mismanagement and structural weaknesses jointly drive CPI inflation.

A number of studies have applied time series methodologies to model and forecast inflation in Nigeria. For example, Nadum *et al* (2020) applied ARMA models on annual inflation data (1961–2019), forecasting steady increases in inflation up to 2024. The effect of inflation within the time was rightly specified in their magnitude and dimension showing an average increment of about 2.4% between 2019 and 2024 with the highest inflationary index being estimated as 13.10 in the year 2024. Hamza (2021) applied ARIMA modeling approach to a monthly inflation data (2009 – 2018), and found ARIMA (2,1,13) the best-fitted model after accounting for structural breaks. The model was used to predict six months' inflation (2018:7 to 2018:12). Wiri *et al* (2021) compared linear ARIMA with non-linear Markov Switching models, and, concluded that, MS-AR models outperform linear approaches for Nigerian Inflation series (January 2006 to December 2019) especially when the series exhibit a regime-switching pattern; the cycle of expansion and contraction. The model was used to predict for a one-year cycle (12 months). Ibrahim *et al* (2022) forecasted CPI and exchange rates using ARIMA (1, 2, 0) and ARIMA (1, 1, 1) respectively, predicting continued rises in both variables.

Given the increasing costs of agricultural products, a comprehensive analysis of inflation in farm produce in Nigeria is crucial. Effective policies must be developed that account for the overall price increases over time. As a result, Olagunju *et al* (2025) emphasizes the significance of price forecasting for agricultural products and seeks to statistically validate predictions for key crops in 2025, utilizing time series data from January 2009 to September 2024. Results were derived using univariate ARIMA modelling techniques. The study shows that the ARIMA model serves as a reliable forecasting tool, with practical models indicating price predictions for 2025. The low values of Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Error (MAE) further affirm the accuracy of these forecasts.

Consumer Price Index (CPI) serves as economic vital indicator that helps decision makers to apply the right approach to investment areas in the midst of limited resources (Awogbemi *et al,* 2025). CPI measures the changes in the broad spectrum level of prices of consumer goods and services that households employ for utilization. Awogbemi *et al,* (2025) seeks to investigate the fluctuations of Nigeria Consumer Price Index from 2009-2024 using an Autoregressive Integrated Moving Average (ARIMA) modelling approach. Forecasts based on the ARIMA (3,2,2) model shows a continuous upward trend in CPI, with the point forecasts suggesting rising inflation rates throughout 2024 and 2025. A Seasoned Autoregressive Integrated Moving Average, SARIMA (3, 2, 2) (2, 0, 0)12 model was also identified as a good fit for the CPI.

Ajayi & Bankole (2025) examined the interconnection of sustainable development and food security in South-West Nigeria, a geopolitical zone characterized by urban-rural disparities and environmental vulnerabilities. Based on a descriptive survey research design, 600 respondents in urban and rural areas supplied the requisite data for the study. Regression and correlation tests guided the study of the socioeconomic and environmental variables that determine household food security and the broader sustainable development results. The study findings establish that 68.5% of the households are food-insecure, and that the key reasons are the rising cost of food, inability of the household to use or own farmland, and post-harvest losses. The study found that land access, household income, education, and market closeness significantly predicted food security (Ajayi & Bankole, 2025). There were strong positive correlations of food security with sustainable development indicators, including household income and education.

Joseph *et al* (2024) examined the relationship between insecurity, exchange rate, inflation rate and agricultural productivity in Nigeria for the period of 1990 to 2024 using the Augmented Granger causality test approach.

3. Methodology

To apply the ARIMA model, the data is presented graphically (time series plot, ACF and PACF) to check for unit root. This can also be tested using Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests (Kwiathowski *et al*, 1992). If the series is not stationary, then, the need for differencing to make it stationary. When it is stationary; identify potential values for p, d, and q (Model Identification), Estimate the parameters of the ARIMA model (Model Estimation), this is done using methods like maximum likelihood estimation. Then, validate the model by checking the residuals (errors) of the model (Diagnostic Checking). The residuals should resemble white noise (i.e., they should be random and not exhibit any patterns), then finally, use the fitted model to make forecasts about future values of the time series (Forecasting). This approach has been used by a number of studies to analyze Time series datasets (see for example–Suleman *et al*, 2015; Umar *et al*, 2019; Tanko *et al*, 2023; Olagunju *et al*, 2025; Zakariyau *et al*, 2025) Gnu Regression, Econometrics and Time-series Library (**Gretl**, Cottrell & Lucchetti, 2024) *software* was used for the analysis.

3.1. Autoregressive Integrated Moving Average (ARIMA) Model

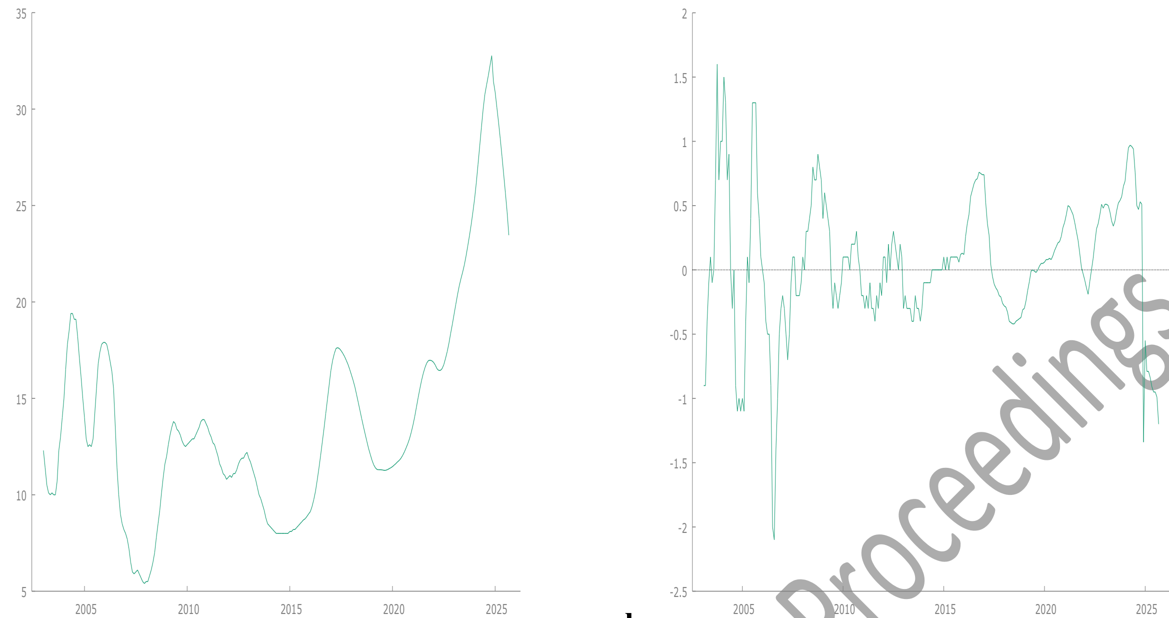
An ARIMA(*p,d,q*) model, where p and q denotes the number of autoregressive and moving average terms, and *d*, the number of times a series has to be differenced to be stationary, is given as:

$$\phi(S)(1-S)^d k_t = \mu + \beta(S)\omega_t \qquad (1)$$

where $\phi(S)$ and $\beta(S)$ are respectively, polynomials of degrees *p* and *q*, and $(1-S)^d = \nabla^d$ is the difference operator, representing the order of the time series differencing, and, ω_t is white noise process, which is independently and normally distributed with zero mean and constant variance, $\omega_t \sim N(0,\sigma^2)$.

4. Results and Discussion of findings

This section presents and interprets the results of the time series modeling of Nigeria’s monthly Consumer Price Index (CPI) using the Box–Jenkins methodology. The analysis follows the four standard stages of model development: identification, estimation, diagnostic checking, and forecasting. Each stage is interpreted to assess the performance and adequacy of the fitted models for forecasting Nigeria’s CPI.

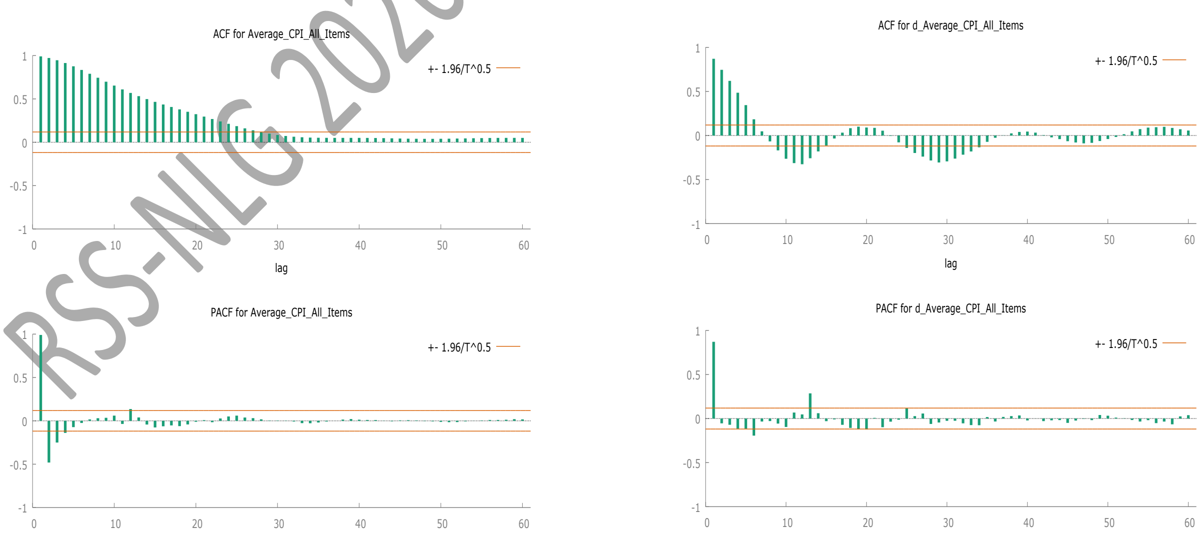


a b

Figure 1: Time Series Plot before and after (first) differencing

Over the period of study, the plot in figure 1 panel **a**, shows that the series has been showing an upward and downward trend pattern, suggesting perhaps that the mean and the variance of the log of Average CPI has been changing with time or over time in Nigeria. However, a visual inspection of the plots in figure 1 panel ***b*** shows that the series has constant mean and variance after the first difference of the series. Nevertheless, this is not the only evidence of stationarity.

The ACF and PACF plots in Figure 2 below, also confirm this, as the ACF decays slowly, signifying that the mean and variance are not constant over time.



a b

Figure 2: Autocorrelation and Partial Autocorrelation Functions of the series before and after (first) differencing

Figure 2 presents the correlogram (ACF and PACF) of the series before and after differencing. The most striking feature of this correlogram is that the autocorrelation coefficients at various lags are very high, (at lag 1 = 0.99) up to a lag of 30 months (at lag 30 = 0.13); these are significantly different from zero, out of the 95% confidence bounds. This is the typical correlogram of a non-stationary time series. Thus, the need for differencing which indicate the series is an ARIMA process. However, most of the lags in the panel ***b*** (differenced series) are not statistically different from zero. Therefore, the series is now stationary.

Table 1: Unit Root Test before and after (first) differencing

Test	Difference Order	Test Statistic	P-value	Remark
ADF	0	-3.034	0.275	Not stationary
	1	-2.835	0.050	Stationary
KPSS	0	0.597	0.042	Not stationary
	1	0.204	0.010	Stationary

The Augmented Dickey–Fuller (ADF) test in Table 1 above supports the observation that the series is not stationary. The test statistic of -1.027 ($p = 0.275$) indicates the presence of a unit root. The KPSS test (statistic = 0.597), with critical values for 10%, 5% and 1% which are 0.12, 0.148 and 0.217 respectively, further supports non-stationarity since the value exceeds the 5% critical value. Hence, the CPI series is non-stationary in levels, and differencing is required.

After the first difference, the CPI series appears more stable (panel **b**, figures 1 and 2). The ACF and PACF exhibit rapid decay, suggesting that the series is now stationary. This is statistically confirmed by the ADF test (at difference order 1 in table 1). All these are below the 5% significance level, implying that the differenced CPI series is stationary. The KPSS statistic (0.204) also falls below the 5% critical value, confirming stationarity. Thus, the CPI series was integrated of order one, $I(1)$, and suitable for ARIMA modeling.

4.1 Model Identification

Model identification involved evaluating candidate ARIMA models based on their Akaike Information Criterion (AIC), Hannan–Quinn Criterion (HQC), and Schwarz Information Criterion (SIC). Among the models tested, ARIMA (3, 1, 2) yielded the lowest AIC values (-20.182), HQC values (-10.049) and SIC values (5.058). This indicates a superior performance relative to others. This suggests that higher-order autoregressive and moving-average terms best capture the underlying dynamics of the CPI data. Therefore, ARIMA (3, 1, 2) was selected for estimation and diagnostic evaluation.

4.2 Model Estimation

Table 2: ARIMA (3, 1, 2) Model Estimation

Parameter (order)	Coefficient	Std. Error	Z-score	P – value
Constant	0.013	0.094	0.135	0.892
AR(1)	2.442	0.052	46.770	<0.001
AR(2)	-2.095	0.098	-21.390	0.002
AR(3)	0.617	0.052	11.980	0.001
MA(1)	-1.754	0.107	-16.410	<0.001
MA(2)	1.000	0.121	8.245	<0.001

For the ARIMA (3,1,2) model, all parameters are statistically significant ($p < 0.001$), indicating a strong and reliable model. The coefficients of φ_1, φ_2, φ_3 (2.442, -2.094, and 0.617) show that the CPI series exhibits strong short-term persistence—past values influence current values substantially. The moving average parameters ($\theta_1 = -1.7539, \theta_2 = 1.000$) effectively capture short-run shocks.

4.3 Model Adequacy Checking

Diagnostic check is usually performed to assess model adequacy. The normality test for ARIMA (3,1,2, $p < 0.001$) shows that residuals deviate from perfect normality (see figure 3), a common occurrence in macroeconomic data due to shocks and volatility. Whereas, Autocorrelation Check (Ljung–Box Q test: $Q = 61.0493$ with $p = 0.2676$) were also computed. Since the p-value exceeds 0.05, residuals are not auto correlated, confirming that the model adequately capture the serial dependence in the CPI series.

As for the ARCH–LM Test for Heteroscedasticity, the model report high p-values (~0.999), suggesting no presence of ARCH effects; hence, constant variance is maintained across time.

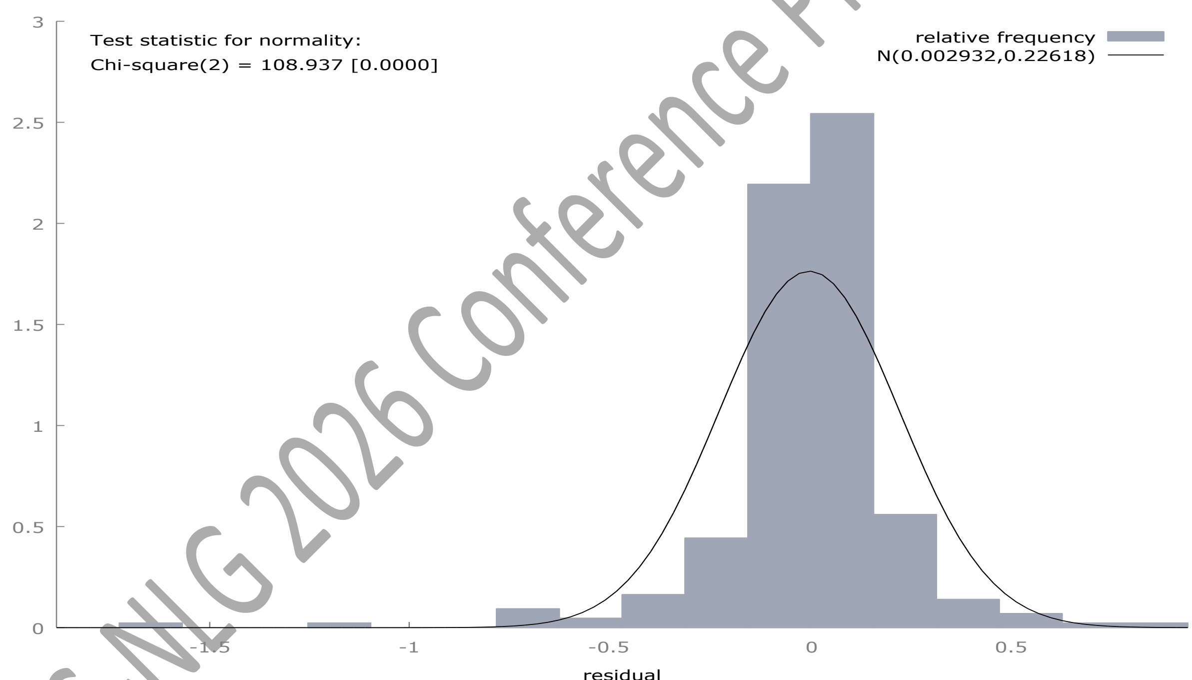


Figure 3: Normality Test of Residuals of the ARIMA (3,1,2) Model

Table 3: Diagnostic Checking for ARIMA (3,1,2) Model

Test	Test Statistic	p-value
Normality Test	108.9370	< 0.001
ARCH-LM	15.1655	0.999
Autocorrelation (Ljung-Box Q)	61.0493	0.2676

The model (ARIMA (3,1,2)) satisfies the adequacy conditions and hence, the model is proved to be adequate for forecasting.

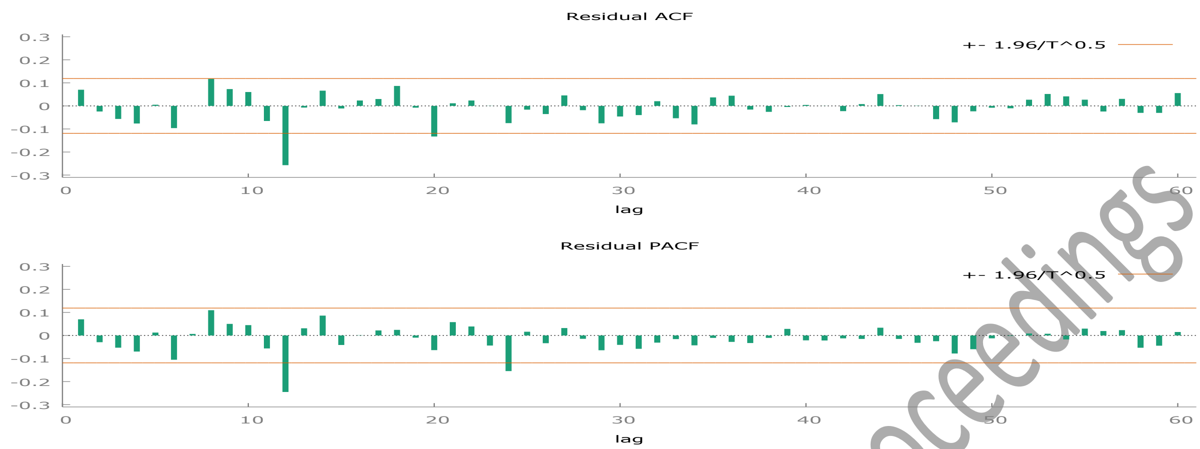


Figure 4: Residual Autocorrelation and Partial Autocorrelation Functions of the ARIMA (3,1,2) Model

4.4 Forecasting

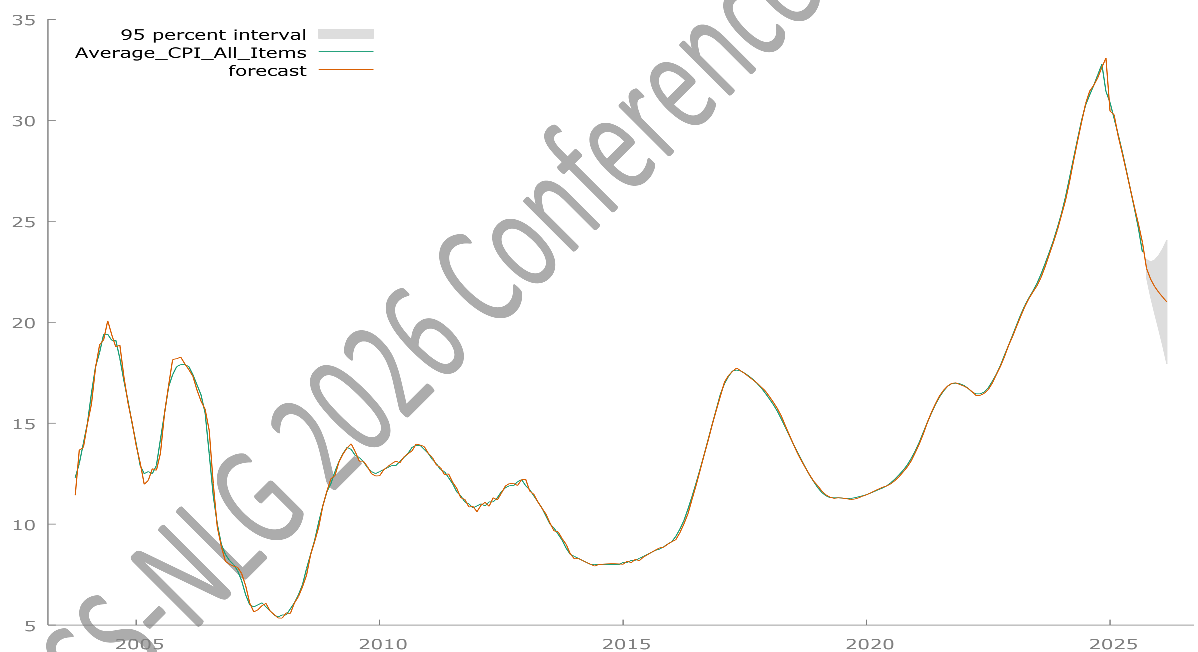


Figure 5: Six-Months Forecast of the Average CPI on all Items using the ARIMA (3,1,2) Model

The six-month and six-month ahead forecasts from the ARIMA(3,1,2) model (Table 4 and Figure 5) show a gradual decline in the predicted CPI, from 30.88 in January 2025 to 21.00 by March 2026. The 95% confidence intervals widen over time, reflecting increased forecast uncertainty.

This decline suggests that Nigeria's CPI inflation may stabilize or decelerate slightly in the forecast horizon if current macroeconomic policies remain consistent. However, this should be interpreted cautiously, as structural shocks (such as fuel price hikes or exchange rate depreciation) could alter future trends.

Table 4: ARIMA (3,1,2) Forecast values for 95% confidence intervals, z(0.025) = 1.96

Year: Month	Average_CPI	Prediction	Std. Error	95% Confidence Interval
2025:04	28.46	28.38		
2025:05	27.55	27.51		
2025:06	26.60	26.60		
2025:07	25.65	25.72		
2025:08	24.66	24.87		
2025:09	23.46	23.95		
2025:10		22.66	0.224	22.23 – 23.10
2025:11		22.13	0.439	21.27 – 22.99
2025:12		21.76	0.672	20.45 – 23.08
2026:01		21.48	0.931	19.65 – 23.30
2026:02		21.23	1.225	18.83 – 23.64
2026:03		21.00	1.559	17.95 – 24.06

4.5 Discussion of Findings

The results align with prior research (Hamza, 2021; Awogbemi *et al,* 2025; Olagunju *et al*, 2025), which identified persistent but controllable inflationary dynamics in Nigeria. The high-order ARIMA models indicate that Nigeria's inflation is influenced by multiple lagged shocks, consistent with structural and monetary factors.

From a public health and food security perspective, these findings are significant. Persistent CPI growth, especially from food inflation, reduces household purchasing power, limiting access to nutritious foods. This can heighten malnutrition, maternal and child morbidity, and overall vulnerability. The slight decline in forecasted CPI suggests potential short-term relief, but the underlying volatility indicates that inflation remains a major public health risk.

The CPI series exhibited a long-term upward trend with evidence of non-stationarity, reflecting persistent inflationary pressures in Nigeria. The best-fitting model for forecasting Nigeria's CPI in this study was ARIMA(3,1,2), which captured the autoregressive and moving average components effectively. This similar model, ARIMA(3,1,2), was found to be the suitable and most efficient among competing models in Olagunju *et al* (2025).

The diagnostic tests confirmed that the model residuals were white noise, showing no significant serial correlation or heteroscedasticity. The forecast results indicated a mild downward trend in CPI, suggesting that inflation may decelerate slightly in the short term.

From a public health perspective, sustained inflation—particularly food inflation—has serious implications for malnutrition (Headey & Ruel, 2023), maternal and child health, and general wellbeing (Movsisyan *et al*, 2024). Persistent inflation weakens household purchasing power, reduces dietary diversity, and can trigger social unrest and insecurity, especially among low-income populations (Lee *et al*, 2013). Inflation is not merely an economic indicator; it is a determinant of health outcomes and human security. High food prices lead to undernutrition, increased disease burden, and reduced productivity (Headey & Ruel, 2023). Thus, effective inflation control should form part of Nigeria's broader public health and food security strategies.

Based on these findings, it is recommended that inflation monitoring and early warning systems be strengthened as well as statistical capacity for policy decision; agricultural productivity and food system resilience be promoted; social protection and nutrition programs be enhanced; integrated economic–health policy frameworks be adopted.

While the ARIMA model performed effectively, it is limited by its linear structure, which may not capture nonlinear economic shocks. At the same time, health data at the same monthly frequency as CPI were not fully available, constraining a detailed joint time series analysis. Therefore, future studies should incorporate nonlinear models (e.g., GARCH, VAR, or machine learning-based models) and obtain high-frequency health data to better understand the dynamic interaction between inflation and public health outcomes in Nigeria.

5. Concluding Remarks

This study examined the effect of Consumer Price Index (CPI) inflation on food security and public health outcomes in Nigeria using a time series modeling framework. By applying the Box–Jenkins methodology to monthly CPI data, the study established that Nigeria's CPI exhibits persistent inflationary dynamics characterized by non-stationarity in levels and strong short-run dependence. After first differencing, the series became stationary, and the ARIMA(3,1,2) model emerged as the most suitable specification based on standard information criteria and diagnostic tests.

The forecasting results suggest a modest deceleration in CPI inflation over the short-to-medium term, provided existing macroeconomic conditions remain stable. However, the widening confidence intervals highlight substantial uncertainty, reflecting Nigeria's exposure to structural shocks such as exchange rate volatility, fuel price adjustments, climate-related disruptions, and insecurity in food-producing regions. These findings indicate that while inflationary pressures may ease temporarily, the underlying volatility of prices remains a significant concern.

Beyond the statistical results, the study demonstrates that CPI inflation has far-reaching implications for food security and public health in Nigeria. Sustained increases in consumer prices—particularly food prices—undermine household purchasing power, restrict access to nutritious diets, and elevate the risks of malnutrition, maternal and child health complications, and reduced overall wellbeing. Inflation therefore operates not only as an economic phenomenon but also as a social and public health risk factor with implications for productivity, poverty, and national stability.

The study contributes to the literature by linking inflation forecasting to food security and public health considerations, an area that remains underexplored in empirical time series research in Nigeria. It provides evidence that effective inflation control should be integrated into broader food system, nutrition, and public health strategies. Policymakers are therefore encouraged to strengthen inflation early-warning systems, promote agricultural productivity and food system resilience, and expand social protection and nutrition-sensitive interventions aimed at protecting vulnerable populations.

While the ARIMA model proved effective in capturing CPI dynamics, its linear structure limits its ability to account for nonlinear shocks and regime changes. Future research should consider extending the analysis using nonlinear time series models, multivariate frameworks, or high-frequency health and nutrition indicators to better capture the complex interaction between inflation, food security, and public health outcomes in Nigeria.

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