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Forecasting Nigeria Inflation Rate Using Autoregressive Integrated Moving Average (ARIMA) Model

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Abstract

This study focuses on forecasting Nigeria's inflation rate using the Autoregressive Integrated Moving Average (ARIMA) model. The research utilizes monthly inflation data from January 2010 to December 2024, obtained from the Central Bank of Nigeria (CBN). The primary objective is to model and forecast inflation trends in Nigeria, which has been experiencing significant inflationary pressures in recent years. The study employs the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to check for stationarity, revealing that the inflation series becomes stationary after a second differencing (I (2)). The ARIMA (2,2,1) model is identified as the best fit based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), providing a balance between model complexity and predictive accuracy. The model reveals strong autoregressive and moving average dynamics, with significant coefficients for AR (1), AR (2), and MA (1) terms. The forecasted inflation rates for 2025 indicate a steady upward trend, with inflation expected to rise from 35.26% in January to 38.93% by December 2025. The findings highlight the persistent inflationary pressures in Nigeria, driven by factors such as currency depreciation, rising food prices, and energy costs. The study

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concludes that the ARIMA (2,2,1) model is effective for forecasting Nigeria's inflation rate and recommends that policymakers implement measures to stabilize the economy, including tighter monetary policies, fiscal discipline, and investments in domestic production to mitigate inflationary pressures. Continuous monitoring and timely adjustments to economic policies are also emphasized to address the ongoing challenges posed by inflation. Additionally, the study recommends diversifying the economy to reduce dependence on oil exports, improving agricultural productivity to curb food price volatility, and enhancing data collection methods for more accurate inflation forecasting.

Keywords: Inflation, Forecasting, Trend, Economy, ARIMA and Stationarity

INTRODUCTION

Inflation is the rate at which the general level of prices for goods and services increases over time, leading to a decline in the purchasing power of money. It is often seen as a broad economic indicator reflecting the rise in the cost of living in a country. According to Nyoni and Bonga (2021), inflation is best described as a sustained and continuous increase in the general price level of goods and services within an economy. A notable consequence of inflation is the depreciation of a country's currency, which can lead to an increase in exchange rates and make imports more expensive. This relationship between exchange rate fluctuations and inflation has been especially visible in Nigeria, where a depreciating naira has significantly influenced the prices of imported goods (Olajide, Ayansola, Odusina & Oyenuga, 2022).

The challenge of maintaining price stability has remained one of Nigeria's most persistent macroeconomic issues. Inflation erodes the value of the national currency, distorts income distribution, and weakens public confidence in the economy. As the Central Bank of Nigeria (2021) points out, price stability is crucial for sustainable economic development and poverty reduction. However, achieving this has proven difficult due to structural weaknesses in the Nigerian economy. Hadrat, Isaac, and Eric (2021) attribute the rising inflation in Nigeria to multiple factors such as low domestic production, rising import costs, currency depreciation, and external shocks like oil price volatility. These factors not only drive inflation but also limit the effectiveness of monetary policy in stabilizing the economy.

In recent years, inflationary pressures in Nigeria have intensified, with widespread social and economic consequences. The rising cost of living has prompted labor unions and civil servants to push for higher wages. At the same time, savings and investment levels have dropped due to uncertainty about future prices, further weakening economic growth (Mbah, Orjime & Mgbemena, 2022). Data from the National Bureau of Statistics (2024) indicate a worrying trend: Nigeria's inflation rate rose from 15.63% in December 2021 to 33.88% in October 2024. This continuous rise suggests significant weaknesses in the country's monetary and fiscal policies.

One of the long-standing contributors to inflation in Nigeria has been the steady increase in petrol prices. Since the 1980s, frequent hikes in fuel prices have led to widespread increases in the cost of transportation, production, housing, and food. In 2012, the price of petrol rose to N97 per liter, and by 2016 it increased further to N145 per liter under a new administration. These increases contributed directly to inflationary pressures (Olugbenga & Oluwabunmi, 2021). More recently, the surge in fuel prices—crossing N500 per liter in 2023—has caused sharp increases in food prices and basic services, turning the goal of price stability into an elusive target (CBN, 2023).

Food inflation, in particular, plays a major role in Nigeria's inflation dynamics due to the heavy weighting of food items in household consumption. As noted by Mbah et al. (2022), a rise in food prices can significantly drive up the overall inflation rate, especially in a country where food constitutes a large portion of household expenditure.

To effectively monitor and forecast inflation trends, time series analysis has become an essential tool in economic research. Time series data refer to observations recorded at regular time intervals, such as monthly inflation rates, quarterly interest rates, or annual GDP figures. As Cochrane (2021) explains, analyzing time series data allows researchers and policymakers to identify trends, detect patterns, and make informed decisions for economic planning and policy development.

Literature Review

Inflation is broadly defined as a persistent rise in the general price level of goods and services within an economy over a period of time, reflecting a reduction in the purchasing power of money (Mankiw, 2016). It is one of the most closely monitored macroeconomic variables due to its significant impact on economic planning, income distribution, investment decisions, and the standard of living. Economists commonly measure inflation

using indices such as the Consumer Price Index (CPI) and the Producer Price Index (PPI), which track changes in the prices of a representative basket of goods and services over time (Samuelson & Nordhaus, 2010).

Inflation can emerge from several sources. Demand-pull inflation arises when aggregate demand in an economy outpaces aggregate supply, leading to upward pressure on prices. Cost-push inflation, on the other hand, occurs when production costs—such as wages and raw materials—rise, prompting producers to pass on the costs to consumers in the form of higher prices. Additionally, structural inflation results from long-term rigidities and inefficiencies in the economic system, such as supply chain constraints and institutional weaknesses (Blanchard & Johnson, 2017).

Several theoretical perspectives help in understanding the dynamics of inflation. The monetarist view, notably advanced by Milton Friedman, posits that inflation is always and everywhere a monetary phenomenon, linked to excessive growth in the money supply relative to output (Friedman, 1968). Meanwhile, the Keynesian perspective emphasizes the role of aggregate demand, wage-price rigidity, and expectations in influencing inflationary trends (Dornbusch, Fischer & Startz, 2014).

In developing economies like Nigeria, inflation is often driven by structural bottlenecks, exchange rate volatility, food supply shocks, and fiscal deficits (CBN, 2023). Nigeria's inflationary trends have also been linked to import dependence, poor infrastructure, and periodic policy inconsistencies (NBS, 2023). The implications of inflation are far-reaching; while mild inflation can stimulate economic activity by encouraging consumption and investment, high or volatile inflation undermines economic stability, erodes real incomes, and hampers long-term growth (IMF, 2022).

Adebayo (2016) studied Nigeria's GDP forecasting from 1960 to 2015, noting the significant challenges posed by the economic recession. Using time series analysis, the study predicted Nigeria's GDP over a ten-year period, revealing a decline from a peak of $568.51 billion in 2014 to $481.07 billion in 2015, with a slow recovery in subsequent years. However, the GDP failed to return to its 2014 peak until the first quarter of 2020.

Adubisi, David, James, Awa, and Terna (2018) studied the use of ARIMA modeling to predict inflation rates. After conducting evaluation and diagnostic checks, the ARIMA (1, 2, 1) model was found to be the most accurate. The residuals from this model were uncorrelated, normally distributed with zero mean, and showed a constant variance,

confirming its suitability. The model's predictions for 2017 were closely aligned with actual inflation rates, indicating its ability to capture the stochastic nature of the inflation series.

Leneenadogo and Essi (2018) applied the SARIMA model to forecast inflation rates in Nigeria from 2003 to 2016. The series was initially found to be non-stationary, but after seasonal differencing, it displayed clear seasonality. Five different models were tested, with the SARIMA (0, 0, 1) x (2, 1, 1)12 model found to minimize the AIC. This model was used to forecast inflation for 2017, and its residuals confirmed the adequacy of the model for forecasting.

Hamza (2021) reviewed inflation forecasting in Nigeria using the ARIMA methodology. This study applied the Box-Jenkins (1976) approach to model and forecast Nigeria's inflation rates using monthly data from January 2009 to December 2018. The dataset was tested for unit roots using the Augmented Dickey-Fuller (1981) test and the Zivot and Andrews test, which accounts for structural breaks. The results confirmed the series as integrated of order one (I(1)) with a structural break in January 2017, leading to the use of sub-sample data from January 2009 to January 2016. The ARIMA (2, 1, 13) model was identified as the best fit, passing all diagnostic checks, and was used to forecast inflation for the second half of 2018. The forecasts were found to be close to the actual inflation figures.

Mustapha, Yusha'u, Seri, and Abubakar (2021) conducted research on forecasting Nigeria's inflation using SARIMA modeling. They highlighted the challenge of seasonality in inflation series, which complicates policy decision-making. Their study, which used monthly data from the Central Bank of Nigeria, applied a Seasonal ARIMA (SARIMA) model, a variation of the ARIMA process. Using 300 data points, the SARIMA (1, 0, 0) x (1, 1, 0)12 model was chosen as the best fit based on its AIC and BIC values. This model was effective in forecasting Nigeria's inflation for 2019.

Omar et al., (2022) conducted a study on forecasting inflation in Egypt for the period 2019-2022 using the AutoRegressive Integrated Moving Average (ARIMA) model. This model was applied to analyze annual inflation rates from 2018 to 2022, with the goal of predicting inflation for the period from August to December 2022. The ARIMA model, identified through the Box-Jenkins methodology, was fitted using EViews10. The ARIMA (1, 1, 1) model was selected as the most appropriate for predicting inflation over the coming months. The forecasted inflation rates for August to December showed slight

variation from the actual values, indicating the importance of sound economic policies to maintain stability in Egypt's inflation.

METHODS

This study applied the ARIMA (Autoregressive Integrated Moving Average) model to analyze and forecast Nigeria's monthly inflation rate from January 2010 to December 2024. Data were obtained from the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS).

Model Specification

The general ARIMA model is denoted as ARIMA(p, d, q), where:

p = number of autoregressive terms (AR),

d = number of differencing needed to make the series stationary,

q = number of moving average terms (MA).

The ARIMA model is defined mathematically as:

$$\Phi_p(B)(1-B)^d Y_t = \Theta_q(B)\varepsilon_t \quad (1)$$

Where:

Y_t = is the actual value at time t,

B = s the backward shift operator (i.e. $BY_t = Y_{t-1}$),

$\Phi_p(B) = 1 - \phi_1 B - \phi_2 B^2 - ... - \phi_p B^p$ is the AR operator,

$\Theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - ... - \theta_q B^q$ is the MA operator,

ε_t is a white noise error term.

Data Transformation and Stationarity Testing

The original series was first plotted and tested for stationarity using the Augmented Dickey-Fuller (ADF) test. The null hypothesis of non-stationarity was rejected if the test statistic was less than the critical value at 5% significance level. If non-stationary, first-order differencing was applied:

$$Y_t' = Y_t - Y_{t-1} \quad (2)$$

Model Identification and Estimation

Autocorrelation (ACF) and partial autocorrelation (PACF) plots were used to identify potential values of p and q. Various ARIMA models were estimated, and the best-fitting model was selected using:

Akaike Information Criterion (AIC):

$$AIC = -2\ln(L) + 2k \quad (3)$$

Bayesian Information Criterion (BIC):

$$BIC = -2\ln(L) + k\ln(n) \quad (4)$$

Where:

L is the maximized likelihood

k is the number of parameters,

n is the sample size.

Forecasting

The validated ARIMA model was used to forecast inflation rates for the next six months. Forecast intervals were constructed as:

$$\hat{Y}_{t+h} \pm z_{\alpha/2}.SE\left(\hat{Y}_{t+h}\right) \quad (5)$$

Where:

$\hat{Y}_{t+h}$ is the point forecast at horizon h,

$SE\left(\hat{Y}_{t+h}\right)$ is the standard error of the forecast,

$z_{\alpha/2}$ is the z-value corresponding to the confidence level (e.g., 1.96 for 95%).

RESULTS AND DISCUSSION

Descriptive Statistic

The descriptive statistics provided in Table 3 offer a comprehensive overview of the dataset, which consists of 180 observations. The data range from a minimum value of 7.70 to a maximum value of 34.80, indicating a significant spread across the dataset. The mean of the dataset is approximately 14.99 with standard deviation of about 6.59, which quantifies the amount of variation or dispersion of the data points from the mean. The variance is approximately 43.49. The skewness of 1.483 indicates that the distribution is positively skewed, meaning it has a longer tail on the right side. This suggests that there are more extreme values on the higher end of the scale than on the lower end. Lastly, the kurtosis value of 1.798 provides insight into the "tailedness" of the distribution. Kurtosis measures how "tailed" or "flat" the distribution is compared to a normal distribution. A kurtosis value less than 3 (the kurtosis of a normal distribution) indicates that the distribution is platykurtic, meaning it has shorter tails and is more spread out around the mean than a normal distribution. However, since the kurtosis value here is close to 3 and slightly less, it suggests a distribution that is somewhat similar to a normal distribution in terms of tail length but might be slightly more spread out.

Table 1: Descriptive Statistic

Measures	Values
N	180
Minimum	7.70
Maximum	34.80
Mean	14.9869
Standard Deviation	6.59439
Variance	43.486
Skewness	1.483
Kurtosis	1.798

Time Series Plot

Figure 1 shows the trend on Nigeria's inflation rate from 2010 to 2024 presents an overall trend of rising inflation, especially from the mid-2010s onward. Initially, between 2010 and 2014, the inflation rate fluctuates within a moderate range, with rates ranging from about

14.4% to a low of 7.7% in early 2014. This suggests that Nigeria experienced a period of relatively controlled inflation during these years. In particular, the rate started high in early 2010 and then saw a gradual decline through 2011 and into 2014, with the rate dipping below 8% by early 2014.

However, from 2015 onward, there is a significant acceleration in inflation. Starting at around 8.2% in January 2015, the inflation rate climbs steadily, reaching double digits by 2016, and peaking at over 18% by December of that year. The steep increase in inflation during 2016 may have been driven by various economic challenges, including the devaluation of the Naira, fuel shortages, and other macroeconomic issues. From 2017 to 2019, the inflation rate remains relatively high but gradually starts to stabilize, fluctuating between 11% and 12%.

A sharp upward trend begins again in 2020, following the economic disruptions caused by the COVID-19 pandemic. By the end of 2020, the inflation rate has escalated to 15.75%, and it continues to rise in the subsequent years. The period from 2021 to 2022 sees inflation rates climbing even higher, surpassing 20%, reaching 21.47% in December 2022. In 2023, the inflation rate soars further, peaking at 28.92% by December 2023. This period marks a continued steep rise, reflecting increasing economic challenges, possibly exacerbated by the country's political instability and global supply chain disruptions.

Entering 2024, the inflation rate continues its upward trajectory, reaching as high as 34.8% by December 2024. The persistent inflationary pressure suggests that the Nigerian economy is still facing significant economic challenges, possibly including currency depreciation, rising food and energy costs, and ongoing fiscal imbalances. This data reflects a trend of sustained inflationary pressure over the past decade, with an especially sharp escalation in recent years, highlighting the struggles of Nigeria's economy in managing inflation and ensuring price stability.

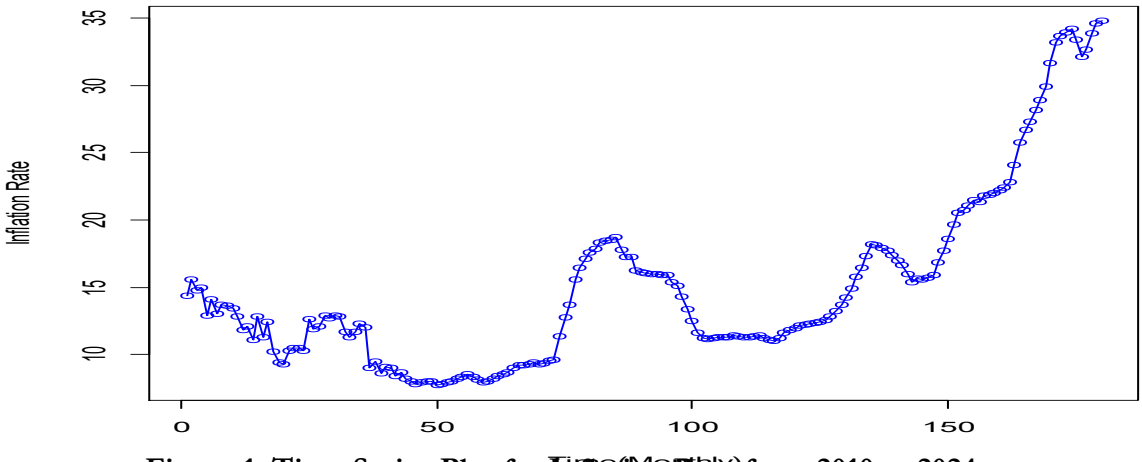


Figure 1: Time Series Plot for Inflation Rate from 2010 to 2024

Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) Plot

The ACF and PACF graph is a tool used to determine if a time series is stationary. A series is considered stationary if its ACF and PACF plot shows a rapid decline or cutoff, indicating that the autocorrelation diminishes quickly. Conversely, if the ACF and PACF plot decays very slowly, the series is likely non-stationary. In the case of the inflation rate time series, Figures 2 and 3 reveal slow decay across all lags, suggesting non-stationarity. However, after differencing the data, as shown in Figures 5 and 6, the ACF and PACF plots exhibit a quick cutoff, indicating that the series becomes stationary after differencing. This transformation helps stabilize the time series, making it more suitable for further analysis.

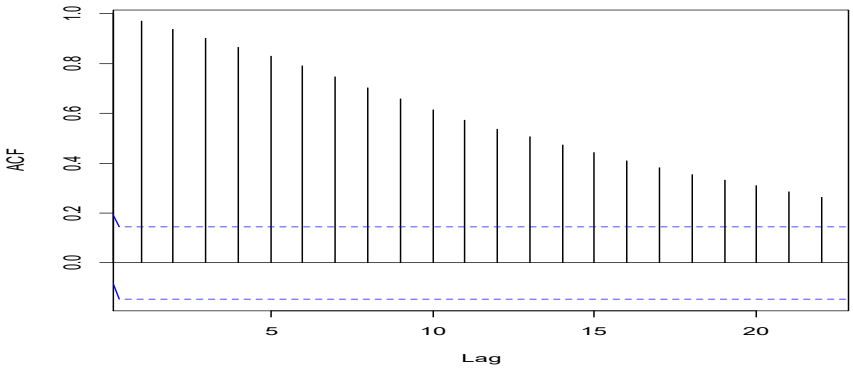


Figure 2: Autocorrelation Function (ACF) plots for Inflation Rate

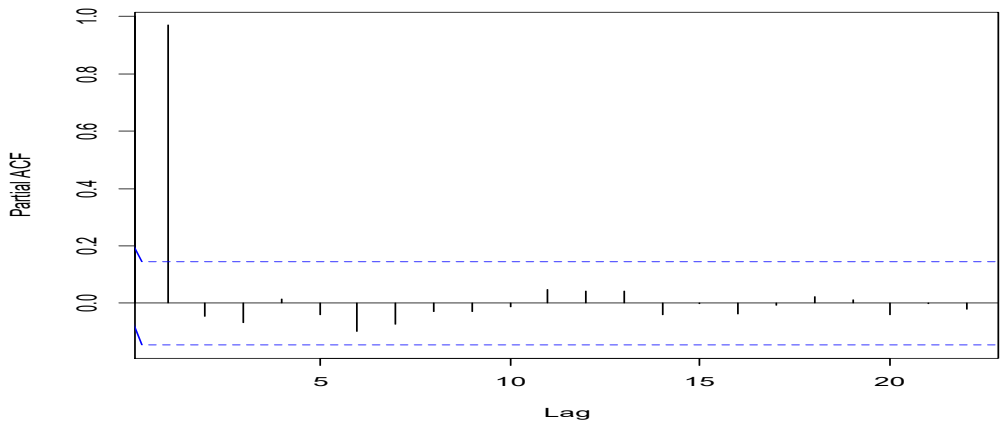


Figure 3: Partial Autocorrelation Function (PACF) plots for Inflation Rate

Stationary test

The results of the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests indicate that the inflation rate series achieves stationarity after second differencing (denoted as I(2)). Both tests decisively reject the null hypothesis of a unit root at the 1% significance level, as evidenced by their p-values of 0.010, which are well below the conventional 5% or 10% thresholds.

The ADF test yields a t-statistic of -4.3779, which is more negative than critical values associated with standard significance levels, confirming strong evidence against non-stationarity. Meanwhile, the PP test reports an even more extreme t-statistic of -190.98, reflecting its robustness in handling potential serial correlation and heteroskedasticity in the data. The alignment between these two distinct methodologies reinforces confidence in the conclusion: the inflation rate series requires second-order differencing to eliminate trends or stochastic trends, making it suitable for time-series analyses like ARIMA modeling.

Table 2: Unit root test

Data	Augmented Dickey-Fuller (ADF) tests		Philips-Perron (PP) Test		Remark
	t-value	P-value	t-value	P-value	
Inflation Rate	-4.3779	0.0100	-190.98	0.010	Stationary at second differencing I(2)

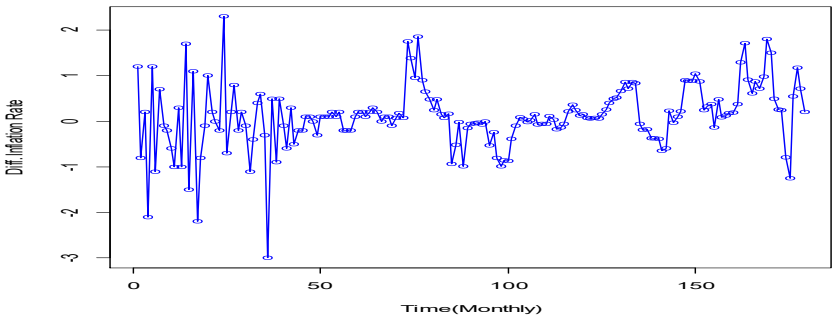


Figure 4: Time Series Plot for Inflation Rate at second differencing from 2010 to 2024

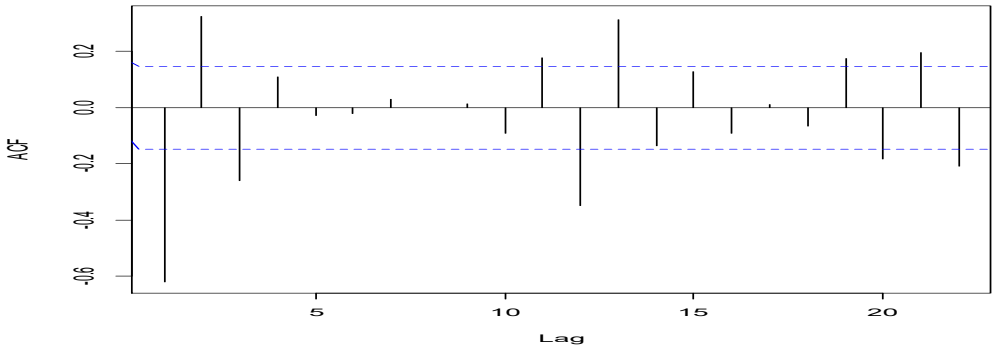


Figure 5: Autocorrelation Function (ACF) plots for Inflation Rate after second differencing

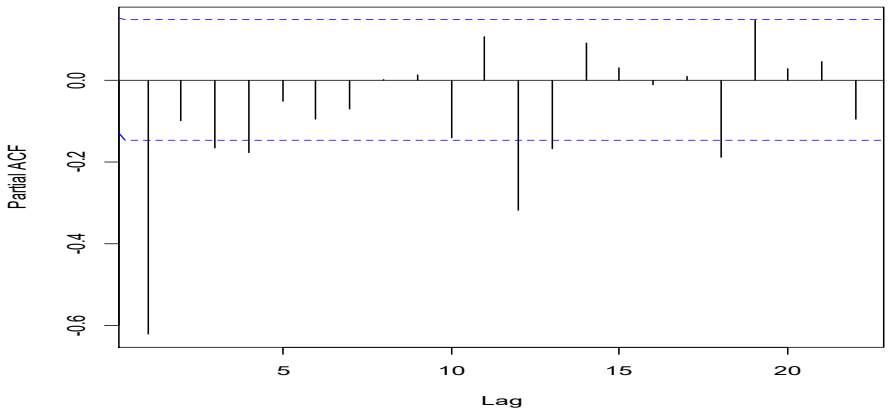


Figure 6: Partial Autocorrelation Function (ACF) plots for Inflation Rate after second differencing

Model Specification

The model selection table presents different ARIMA (AutoRegressive Integrated Moving Average) models with corresponding values for AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion). These are statistical measures used to compare and evaluate the relative fit of the models to the data. Lower values for both AIC and BIC indicate a better fit, as they balance model complexity with goodness of fit.

Upon reviewing the models, the ARIMA (2,2,1) model stands out as the best fit, marked with an asterisk (*) in the table. This model has the lowest AIC (356.51) and BIC (371.23) values compared to the other models, suggesting that it strikes the best balance between model complexity and the ability to explain the data. The AIC and BIC values for this model are lower than those for other candidate models, indicating that it is the most efficient model in terms of statistical fit.

Other models, such as ARIMA (2,2,2) and ARIMA (1,2,2), also show relatively good fit with AIC and BIC values of 357.60/375.51 and 368.17/382.89, respectively, but they do not perform as well as the ARIMA (2,2,1) model. Additionally, models with higher values for AIC and BIC, such as ARIMA (2,2,0) (AIC: 378.86, BIC: 390.40) and ARIMA (1,2,1) (AIC: 373.00, BIC: 384.54), are less favorable. These higher values indicate poorer model fit compared to the optimal ARIMA (2,2,1). Overall, the ARIMA (2,2,1) model is the best choice based on the AIC and BIC criteria, making it the most appropriate model for the data at hand.

Table 3: Model Selection

S/N	Model	AIC	BIC
1.	ARIMA (0,2,1)	372.72	381.08
2.	ARIMA (2,2,2)	357.60	375.51
3.	ARIMA (1,2,2)	368.17	382.89
4.	ARIMA (2,2,1)	356.51*	371.23*
5.	ARIMA (1,2,1)	373.00	384.54
6.	ARIMA (2,2,0)	378.86	390.40
7.	ARIMA (3,2,1)	357.78	375.69
8.	ARIMA (1,2,0)	379.04	387.40
9.	ARIMA (3,2,0)	373.25	387.97
10.	ARIMA (3,2,2)	359.59	380.68

Interpretation of best fit models

The ARIMA(2,2,1) model reveals a autoregressive and moving average dynamics. The model employs second-order differencing (d=2) to stabilize the time series, paired with two autoregressive terms (AR(1) and AR(2)) and one moving average term (MA(1)). Both AR terms are statistically significant ($p < 0.001$), with AR(1) = -1.6208 and AR(2) = -0.6670, indicating strong negative autocorrelation with prior values. The magnitude of AR(1) is particularly notable, as coefficients exceeding |1| can signal potential non-stationarity despite differencing, raising questions about the model's stability. The MA(1) term at -0.9825 is also highly significant, reflecting a near-perfect inverse relationship with recent forecast errors. However, its proximity to -1 introduces risks of overfitting or numerical instability in predictions. The constant term (-0.00012) is negligible and statistically irrelevant ($p = 0.9999$), suggesting no deterministic trend remains after differencing.

Table 4: Autoregressive Integrated Moving Average with p=2, d=2 and q=1 (ARIMA (2,2,1))

	Coefficient	Standard Error	t-value	P-value
Constant	-0.00012	0.09923	-0.0000	0.9999
AR (1)	-1.6208	0.0568	-28.56	0.0000*
AR (2)	-0.6670	0.0568	-11.75	0.0000*
MA (1)	-0.9825	0.0007	1471.51	0.0000*

Forecasting

The forecasted inflation rates for Nigeria from January to December 2025 suggest a consistent upward trend in inflation throughout the year. Starting at 35.26% in January 2025, the inflation rate is projected to gradually increase month by month, reaching 38.93% by December 2025. This steady rise, though relatively moderate month-to-month, indicates that inflation will continue to be a significant economic concern for the country in 2025.

The inflation rate increases by approximately 0.30% to 0.35% each month, with the rate forecasted to surpass 36% as early as May 2025. By the end of the year, inflation is expected to reach nearly 39%, which is a worrying continuation of the high inflationary pressures experienced in previous years. This forecast suggests that Nigeria will face ongoing economic challenges, with inflationary pressures likely being driven by factors such as high food prices, currency depreciation, and possible macroeconomic instability.

Overall, the predicted inflation trajectory indicates a persistently high cost of living throughout 2025, impacting both consumers and businesses.

Table 5: Forecasting of Inflation Rate from January, 2025 to December, 2025

Months/Year	Inflation Rate
January, 2025	35.26
February , 2025	35.55
March, 2025	35.93
April, 2025	36.25
May, 2025	36.60
June, 2025	36.93
July, 2025	37.27
August, 2025	37.60
September, 2025	37.93
October, 2025	38.27
November, 2025	38.60
December, 2025	38.93

CONCLUSION

The statistical analysis and model selection identify the ARIMA (2,2,1) model as the most appropriate for forecasting, ensuring robust predictions for future inflation trends. The forecasted inflation rate for 2025 suggests continued economic pressures, with a sustained increase in inflation throughout the year. The stationarity tests validate the time series' suitability for ARIMA modeling, contributing to the reliability of the forecasts.

Recommendations

Based on the findings of this study, which forecasted a persistent rise in Nigeria's inflation rate to 38.93% by December 2025 using the ARIMA (2,2,1) model, the following targeted recommendations are proposed to mitigate inflationary pressures and stabilize the economy:

i. The CBN should raise interest rates to control money supply and inflation expectations, given the persistent trends shown in the ARIMA model.
ii. Reduce reliance on oil exports and support domestic production of essential goods to ease currency depreciation and import costs.

iii. Gradually phase out fuel subsidies while improving tax collection to reduce fiscal deficits fueling inflation.

iv. Address food and energy supply shocks by boosting farm productivity and renewable energy infrastructure.

v. Regularly update forecasts with real-time data to enable proactive policy adjustments.

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