Modeling the Nigerian Inflation Rates Using Periodogram and Fourier Series Analysis

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This work considers the application of Periodogram and Fourier Series Analysis to model all-items monthly inflation rates in Nigeria from 2003 to 2011. The main objectives are to identify inflation cycles, fit a suitable model to the data and make forecasts of future values. To achieve these objectives, monthly all-items inflation rates for the period were obtained from the Central Bank of Nigeria (CBN) website. Periodogram and Fourier series methods of analysis are used to analyze the data. Based on the analysis, it was found that inflation cycle within the period was fifty one (51) months, which coincides with the two administrations within the period. Further, appropriate significant Fourier series model comprising the trend, seasonal and error components is fitted to the data and this model is further used to make forecast of the inflation rates for thirteen months. These forecasts compare favourably with the actual values for the thirteen months.

Key words: Fourier series analysis, periodogram, frequency domain, time series, forecasting.

JEL Subject Classification: E31, E37.

1.0 Introduction

Inflation is a persistent rise in the general price levels of goods and services in an economy over a period of time. Inflation rate has been regarded as one of the major economic indicators in any country. According to Olatunji *et al*. (2010), inflation is undeniably one of the leading and most dynamic macro-economic issues confronting almost all economies of the world. Its dynamism has made it an imperative issue to be considered.

Its importance to the economic growth of a country makes many researchers and economists to apply various time series and econometric models to forecast or model inflation rates of countries. These models include Autoregressive Integrated Moving Average (ARIMA) Models and Seasonal Autoregressive Integrated Moving Average (SARIMA) Models all in the time

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domain, error correction, VAR and other econometric models, but not much have been done using the Frequency domain models.

This paper explores the frequency domain approach to model inflation rates as a time series, using periodogram and Fourier series analysis methods, because of their simple way of modeling seasonality and eliminating significant peaks without re-estimating the model. Periodogram analysis enables one to identify cycles or periods in series. We also seek to use this model to make forecasts of future values.

Gary (1995) analyzed the dominant factors influencing inflation in Nigeria using an error correction model based on money market equilibrium conditions. In his analysis, he found that monetary expansion driven mainly by expansionary fiscal policies, explains to a large extent the inflationary process in Nigeria. Some econometric models have been used to describe inflation rates, but they are restrictive in their theoretical formulations and often do not incorporate the dynamic structure of the data and have tendencies to inflict improper restrictions and specifications on the structural variables (Saz, 2011).

Odusanya and Atanda (2010) determined the dynamic and simultaneous interrelationship between inflation and its determinants – growth rate of Gross Domestic Product (GDP), growth rate of money supply (M_2), fiscal deficit, exchange rate (U.S dollar to Naira), importance and interest rates, using econometric time series model. Olatunji *et al*. (2010) examined the factors affecting inflation in Nigeria using cointegration and descriptive statistics. They observed that there were variations in the trend pattern of inflation rates and some variables considered were significant in determining inflation in Nigeria. These variables include annual total import, annual consumer price index for food, annual agricultural output, interest rate, annual government expenditure, exchange rate and annual crude oil export.

Mordi *et al*. (2007), in their study of the best models to use in forecasting inflation rates in Nigeria identified areas of future research on inflation dynamics to include re-identifying ARIMA models, specifying and estimating VAR models and estimating a P-Star model, amongst others that can be used to forecast inflation with minimum mean square error.

Stockton and Glassman (1987) conducted a comparative study on three different inflation processes namely rational expectations model, monetarist model and the expectation augmented Philips curve that are based on economic theory relationships that explain and form inflation. These processes were compared to one another, utilizing their out-of-sample forecast performance on an eight-quarter horizon and in addition a simple Autoregressive Integrated Moving Average (ARIMA) model was used as a bench mark to substantiate the theoretical validity of the econometric models. Their findings showed that the ARIMA model outperformed both the rational expectations model and the monetarist model and was found to perform just as good as the Philips curve in all specifications. They concluded that despite all theoretical efforts to explain causes of inflation, a simple ARIMA model of inflation turned in such a respectable forecast performance relative to the theoretically based specifications.

A reason why simple time series models tend to outperform their theoretical counterparts lies in the restrictive nature of econometric models with their improper restriction and specifications on structural variables. The absence of restriction in the ARIMA model gives it the necessary flexibility to capture dynamic properties and thus significant advantage in short-run forecasting (Saz, 2011). Encouraged by these empirical results on the superiority of ARIMA models, Saz (2011) applied Seasonal Autoregressive Integrated Moving Average (SARIMA) model to forecast the Turkish inflation. Longinus (2004) examined the influence of the major determinants of inflation with a particular focus on the role of exchange rate policy of Tanzania from 1986 to 2002. He discovered that the parallel exchange rate had a stronger influence on inflation. Other works on modeling inflation rates are seen in the works of Fatukasi (2003), Eugen *et al.* (2007) and Tidiane (2011).

Having known the advantages of using Fourier Series Analysis to model periodic data, Ekpenyong and Omekara (2007) modeled the mean monthly temperature of Uyo Metropolis using Fourier Series Method. Also Ekpenyong (2008) modeled rainfall data using Pseudo-additive Fourier series model, which he modified from Fourier Series Model. In the same vein, we seek to use Fourier Series Analysis and Periodogram analysis to investigate the properties of inflation rates in Nigeria and also model the rates so as to make good forecast of it.

2.2 Method of Analysis

The main methods of analysis of this work are periodogram and Fourier series analysis. If the series is largely influenced by seasonality or periodicity, one can immediately inspect and guess the period or the frequency of the series; but if the period of the series cannot be guessed accurately, it calls for the construction of a periodogram to determine the period or frequency of the series.

In this work, we seek to model inflation rates of Nigeria using these methods. Since inflation is affected by other factors, periodogram analysis becomes necessary to determine the inflation cycle of the series for the period under study. The data for this work are "All-items inflation rates", from 2003 to 2011, which are obtained from the Central Bank of Nigeria website (www.cbn.gov.ng).

In constructing the periodogram, time series is viewed in the frequency-domain view point as one that consists of sine and cosine waves at different frequencies.

$$X_t = T_t + \sum_{i=1}^{N} \left[a_i Cos\omega_i t + b_i Sin\omega_i t\right] + Z_t \qquad (1)$$

Where : T_t is the trend equation
X_t is inflation rate at time t
$\omega_i$is the angular frequency measured in radians
Z_t is the error term
a_i, b_i are the coefficients

In short, the series consists of the trend, seasonal and error components. The series is first detrended and the ordinary least squares estimates of the parameters obtained on the detrended series as:

$$\hat{a}_i = \frac{2}{N}\sum_{t=1}^{N} \Delta X_t \cos \omega_i t \qquad (2)$$

$$\hat{b}_i = \frac{2}{N}\sum_{t=1}^{N} \Delta X_t \sin \omega_i t \qquad (3)$$

Since $\sum_{t=1}^{N} \cos \omega_i t \cos \omega_j t = \begin{cases} 0, i \neq j \\ \frac{N}{2}, i = j \end{cases}$ (4)

$$\sum_{t=1}^{N} \sin \omega_i t \sin \omega_j t = \begin{cases} \frac{N}{2}, i \neq j \\ 0, i = j \end{cases} \quad (5)$$

$$\sum_{t=1}^{N} \sin \omega_i t \cos \omega_j t = 0 \; \forall \; i, j \quad (6)$$

And $\sum_{t=1}^{N} \sin \omega_i t = 0$ (7)

$$\sum_{t=1}^{N} \cos \omega_i t = 0 \;\; \text{for} \, 1 < i < N/2, \; where \; \omega_i = 2\pi f_i$$

The above results are obtained from complex variables as orthogonality and independent properties of Fourier Series or sinusoidal models. In case of time series with even number of observations N = 2q, q = N/$_2$, the same definitions are applicable except for

$$\hat{a}_q = \frac{1}{N} \sum_{i=0}^{N} (-1) \, \Delta X_t \qquad \hat{b}_q = 0 \quad (9)$$

Therefore the Periodogram for a time series ΔX_t with N = 2q + 1 (odd number of observations) is defined as the function of intensities $I(f_i)$ at frequency f_i as:

$$I(f_i) = \frac{N}{2} \left[a_i^2 + b_i^2 \right], \; i = 1, 2, ..., q \quad (10)$$

where f_i is the ith harmonic of frequency $\frac{1}{N}$ and $0 \leq f_i \leq 0.5$

for even number of observations,

$$I(f_{0.5}) = N a_q^2 \quad (11)$$

The plot of the intensities against the frequencies (f_1) or periods $\left(\frac{1}{f_i}\right)$ is the periodogram.

The periodogram measures the amplitude of a time series for all possible frequencies and wavelengths. It can be interpreted as the amount of the total series sums of squares that is explained by specific frequencies. The period or frequency of the series is identified as that with the largest intensity, $I(f_i)$. The frequency would then be used as the Fourier frequency f_i to obtain the parameter estimates of the model. It is noted here that the period obtained from the periodogram would give the inflation cycle. The period or frequency obtained is now used as Fourier frequency to fit a Fourier series model to the inflation rates data.

The combination of methods of estimating the components of time series gives a general model of Fourier series analysis used in forecasting time series.

The general Fourier series model is given by:

$$X_t = T_t + \sum_{i=1}^{k} [\alpha_i \cos i\omega t + \beta_i \cos i\omega t] + Z_t \tag{12}$$

The estimated model for forecasting time series is given by:

$$\hat{X}_t = \hat{T}_t + \sum_{i=1}^{k} \left[\hat{\alpha}_i \cos i\omega t + \hat{\beta}_i \cos i\omega t\right] \tag{13}$$

where $\hat{X}_t$ = estimated values of inflation

$\hat{T}_t$ = estimated trend equation

$\hat{\alpha}_i,\ \hat{\beta}_i\ (i = 1, \ldots, k)$ = parameter estimates

ω_i = $2\pi f_i$

k = highest harmonic of ω

The highest harmonic, k in Fourier series analysis model is the number of observations per season divided by two (2) for an even number of observations and (n – 1)/2 for an odd number of observations (Priestly, 1981).

The trend is first isolated or removed by fitting the linear trend model or quadratic trend or even the overall mean of the data, using the method of least squares. The trend equation is fitted based on its significance in the model. Thus the trend equation includes:

$$X_t = a_0 + a_1 t + a_2 t^2 + \ldots + a_p t^p \qquad (14)$$

Where

$$a_0 = \mu = \frac{\sum X_t}{N}$$

The trend, after estimating, is now removed from series and the detrended series used to estimate seasonal variation.

The sine and cosine functions in equation (13) give the estimated model for the seasonality of the model. It is given by:

$$\Delta \hat{X}_t = \sum_{i=1}^{k} \left[\hat{\alpha}_i \cos i\omega t + \hat{\beta}_i \cos i\omega t \right] \qquad 15)$$

where $\Delta \hat{X}_t = \hat{X}_t - \hat{T}_t$

The above equation is cast as a multiple linear regression to obtain the estimates of α_i and β_i.

To estimate Z_t, we first of all determine if the residual values are random. This can be done by assessing the autocorrelation function of the residual. If the residual or error component is not random, a first order autoregressive model can be fitted to the error values as:

$$Z_t = \phi Z_{t-1} + \mu_t \qquad (16)$$

Where

ϕ	=	the autoregressive coefficient
μ_t	=	the purely random process (white noise)

The estimated equation is given as:

$$\hat{Z}_t = \hat{\phi} Z_{t-1} \tag{17}$$

These estimations are done using MINITAB. A combination of these three components gives the general Fourier series model used to estimate Inflation rates. This model is then used to estimate inflation rates of Nigeria and make forecasts for future values of inflation rates. In testing for the adequacy of the forecasts, Theil Inequality Coefficient is used. The Theil coefficient is given as:

$$U = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(X_i - \widehat{X}_i)^2}}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}X_i^2} + \sqrt{\frac{1}{n}\sum_{i=1}^{n}\widehat{X}_i^2}} \tag{18}$$

Where X_i and $\widehat{X}_i$ are the actual and estimated inflation rates respectively; n is the number of observations. The closer the value of U is to zero the better the forecasts.

3.0 Data Analysis

A clear assessment of the graphical representation of original series shows that there is an existence of trend, cyclical and seasonal variations, but the cycle or period of the series cannot be exactly ascertained (see Figure 1). In addition the normal probability plot of the series in Figure 2 indicates that the series is not normal or stable. It is therefore important to transform the data for stability and normality. A square root transformation was therefore appropriate as shown in Figure 3.

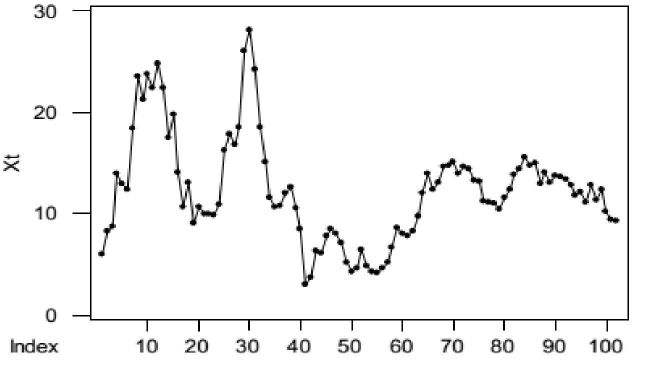

Figure 1: Plot of Original Series(All-items Inflation Rate)

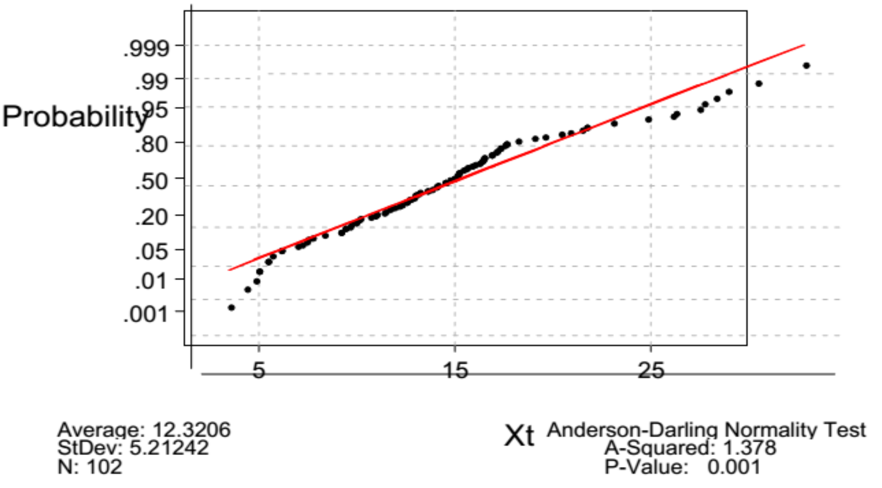

Figure 2: Normal P-P Plot of the Series

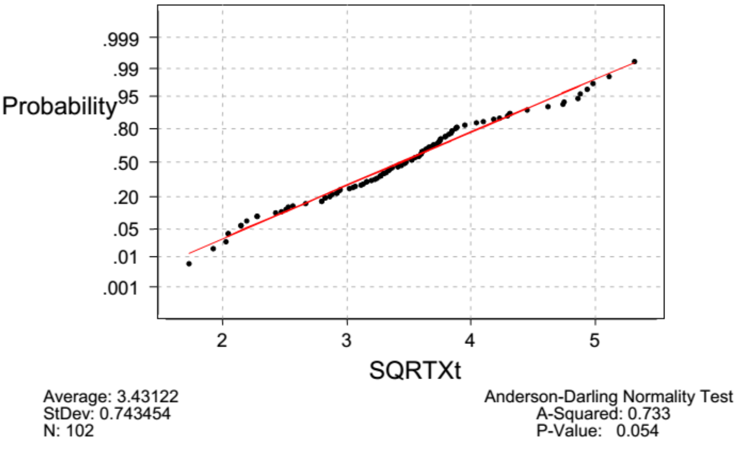

Figure 3: Normal P-P Plot of the transformed Series

3.2 Periodogram Analysis

The intensities $I(f_i)$ at various frequencies are obtained using equations (2), (3) and (10) as shown in Table 1. The plots of these intensities against the frequencies and periods are given in figures 4 and 5. From figures 4 and 5, it is observed that the frequency and period with the largest intensity are 0.0196 and 51 months respectively. This is also shown in Table 1 of this work. Hence the period or cycle for the data is 51 months. These are now used to fit the Fourier series model to the data.

Table 1: Estimates, Frequencies, Period and Intensities

a	b	a**2	b**2	I(f)	f	PERIOD	a	b	a**2	b**2	I(f)	f	PERIOD
8.4864	0.663	72.019	0.44	72.459	0.0098	102	1.377	-0.9282	1.896	0.862	2.758	0.26471	3.778
-30.243	1.6932	914.639	2.867	917.506	0.01961	51	2.6724	0.8976	7.142	0.806	7.947	0.27451	3.643
7.5888	0.0204	57.59	0	57.59	0.02941	34	0.3774	2.346	0.142	5.504	5.646	0.28431	3.517
-13.505	7.6398	182.38	58.367	240.746	0.03922	25.5	-1.1016	0.4488	1.214	0.201	1.415	0.29412	3.4
-21.828	3.8556	476.462	14.866	491.327	0.04902	20.4	0.8772	-1.122	0.769	1.259	2.028	0.30392	3.29
-2.142	-15.841	4.588	250.925	255.5	0.05882	17	-1.224	0.5202	1.498	0.271	1.769	0.31373	3.188
3.5598	-6.0486	12.672	36.586	49.258	0.06863	14.571	1.224	-1.0914	1.498	1.191	2.689	0.32353	3.091
-1.9482	-4.2228	3.795	17.832	21.628	0.07843	12.75	0.0918	0.8058	0.008	0.649	0.658	0.33333	3
-2.652	-0.0204	7.033	0	7.034	0.08824	11.333	-0.0816	-0.2958	0.007	0.087	0.094	0.34314	2.914
0.4284	-4.9062	0.184	24.071	24.254	0.09804	10.2	0	0.8058	0	0.649	0.649	0.35294	2.833
4.4778	1.581	20.051	2.5	22.55	0.10784	9.273	-1.9278	-0.6732	3.716	0.453	4.17	0.36275	2.757
-5.5182	-1.6932	30.451	2.867	33.317	0.11765	8.5	0.9588	-2.2134	0.919	4.899	5.818	0.37255	2.684
0.5916	-6.4056	0.35	41.032	41.382	0.12745	7.846	0.8058	-2.3052	0.649	5.314	5.963	0.38235	2.615
0.7344	4.2126	0.539	17.746	18.285	0.13726	7.286	1.5606	-1.6728	2.435	2.798	5.234	0.39216	2.55
-4.4472	-3.927	19.778	15.421	35.199	0.14706	6.8	2.8764	0.9792	8.274	0.959	9.233	0.40196	2.488
2.7948	0.6324	7.811	0.4	8.211	0.15686	6.375	4.2126	0.4182	17.746	0.175	17.921	0.41177	2.429
-0.9996	-0.153	0.999	0.023	1.023	0.16667	6	0.6528	-0.7038	0.426	0.495	0.921	0.42157	2.372
-2.346	0.2142	5.504	0.046	5.55	0.17647	5.667	-0.0612	-0.2346	0.004	0.055	0.059	0.43137	2.318
0.459	-2.8458	0.211	8.099	8.309	0.18628	5.368	1.734	-2.346	3.007	5.504	8.51	0.44118	2.267
-0.6222	-2.1828	0.387	4.765	5.152	0.19608	5.1	1.2546	-1.0812	1.574	1.169	2.743	0.45098	2.217
1.8462	0.0306	3.408	0.001	3.409	0.20588	4.857	0.2448	-0.7548	0.06	0.57	0.63	0.46078	2.17
-1.2138	-0.6426	1.473	0.413	1.886	0.21569	4.636	-0.4488	-1.275	0.201	1.626	1.827	0.47059	2.125
-0.0102	-4.5186	0	20.418	20.418	0.22549	4.435	0.7038	-0.255	0.495	0.065	0.56	0.48039	2.082
3.6006	0.5712	12.964	0.326	13.291	0.23529	4.25	0.9282	-0.306	0.862	0.094	0.955	0.4902	2.04
0.6426	-1.3158	0.413	1.731	2.144	0.2451	4.08	1.7442	-0.0112	3.042	0	3.042	0.5	2
1.1424	-0.1632	1.305	0.027	1.332	0.2549	3.923							

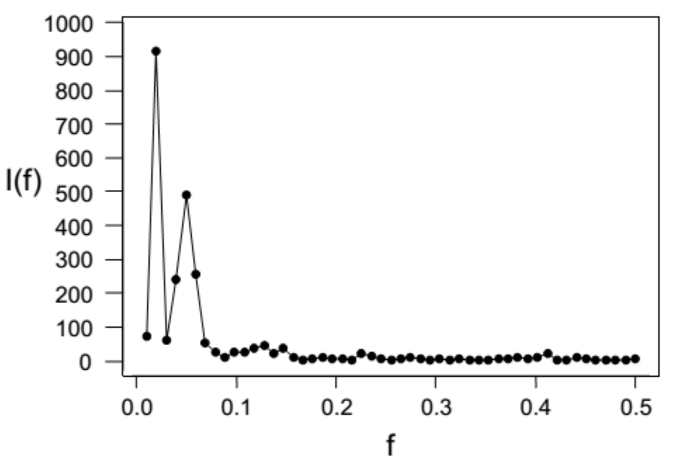

Figure 4: Plot of Intensities against Frequency

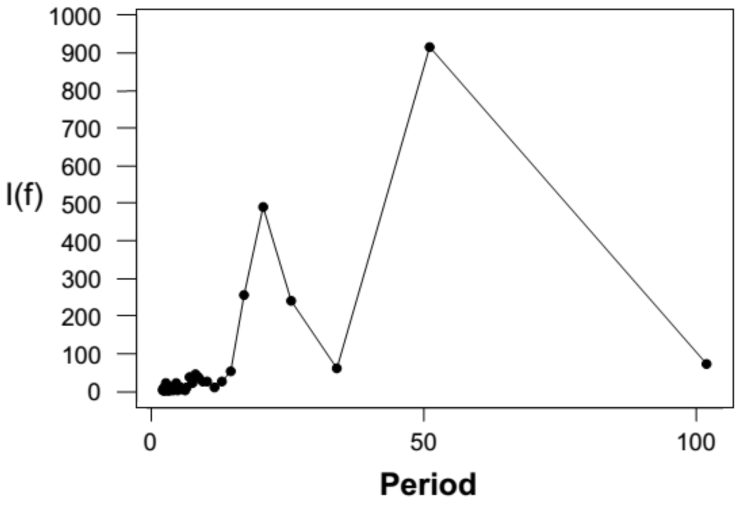

Figure 5: Plot of Intensities against Periods

3.3 Fitting the General Fourier Series Model

The trend (T_t) is estimated as:

$$T_t = a_0 + a_1 t$$

Its analysis is given in Table 2 with a trend equation given as:

$$\hat{T}_t = 3.6529 - 0.0043t$$

Table 2: Test for Significance of the Parameter Estimates in the Trend Model

Predictor	Coef	StDev	T	P
Constant	3.6529	0.1469	24.87	0
T	-0.0043	0.002475	-1.74	0.085
S = 0.7361	R-Sq = 2.9%		R-Sq(adj) = 2.0%	

From Table 2, it is seen that the parameter estimate $a_o$only is significant in the trend equation at 5% level of significance. Therefore T_t = 3.6529.

The seasonal component is then estimated from the detrended series as:

$$k = \frac{(n-1)}{2} = \frac{51-1}{2} = 50/2 = 25$$

$$and\ \omega = 2 \times \pi \times 0.019608$$

$$\therefore X_t = \sum_{i=1}^{25} \left[\alpha_i Cosi\omega t + \beta_i Sini\omega t\right]$$

The parameters $a_i^{'s}$ and $\beta_i^{'s}$ are obtained by method of least squares as shown in Table3.

Table 3: Test for Significance of the Parameter Estimates in the Seasonal Component

Predictor	Coef	StDev	T	P	Predictor	Coef	StDev	T	P
Noconstant					Noconstant				
Coswt	-0.5071	0.1041	-4.87	0	sin13wt	-0.0025	0.1041	-0.02	0.981
Sinwt	0.0387	0.1041	0.37	0.712	cos14wt	0.0529	0.1041	0.51	0.613
cos2wt	-0.2432	0.1041	-2.34	0.023	sin14wt	0.0183	0.1041	0.18	0.861
sin2wt	0.1524	0.1041	1.46	0.149	cos15wt	-0.0212	0.1041	-0.2	0.839
cos3wt	-0.0323	0.1041	-0.31	0.758	sin15wt	0.0095	0.1041	0.09	0.928
sin3wt	-0.3088	0.1041	-2.97	0.005	cos16wt	-0.0235	0.1041	-0.23	0.822
cos4wt	-0.0326	0.1041	-0.31	0.756	sin16wt	0.0108	0.1041	0.1	0.918
sin4wt	-0.0813	0.1041	-0.78	0.438	cos17wt	0.0021	0.1041	0.02	0.984
cos5wt	0.012	0.1041	0.12	0.909	sin17wt	0.0165	0.1041	0.16	0.875
sin5wt	-0.0951	0.1041	-0.91	0.365	cos18wt	0.0004	0.1041	0	0.997
cos6wt	-0.1057	0.1041	-1.01	0.315	sin18wt	0.0164	0.1041	0.16	0.875
sin6wt	-0.0322	0.1041	-0.31	0.759	cos19wt	0.0192	0.1041	0.18	0.855
cos7wt	0.0163	0.1041	0.16	0.876	sin19wt	-0.0428	0.1041	-0.41	0.683
sin7wt	0.0834	0.1041	0.8	0.427	cos20wt	0.0309	0.1041	0.3	0.768
cos8wt	0.0563	0.1041	0.54	0.591	sin20wt	-0.0322	0.1041	-0.31	0.759
sin8wt	0.0132	0.1041	0.13	0.9	cos21wt	0.0041	0.1042	0.04	0.969
cos9wt	-0.0449	0.1041	-0.43	0.668	sin21wt	0.0088	0.1041	0.08	0.933
sin9wt	0.005	0.1041	0.05	0.962	cos22wt	-0.0011	0.1042	-0.01	0.992
cos10wt	-0.0113	0.1041	-0.11	0.914	sin22wt	-0.0039	0.1041	-0.04	0.97
sin10wt	-0.042	0.1041	-0.4	0.688	cos23wt	0.0248	0.1042	0.24	0.813
cos11wt	-0.023	0.1041	-0.22	0.826	sin23wt	-0.0205	0.1041	-0.2	0.845
sin11wt	-0.0119	0.1041	-0.11	0.91	cos24wt	-0.0086	0.1042	-0.08	0.935
cos12wt	0.0714	0.1041	0.69	0.496	sin24wt	-0.0243	0.104	-0.23	0.816
sin12wt	0.0119	0.1041	0.11	0.91	cos25wt	0.0184	0.1045	0.18	0.861
cos13wt	0.023	0.1041	0.22	0.826	sin25wt	-0.0052	0.1038	-0.05	0.961
					S = 0.7436				

From Table3, it is observed that the parameter estimates that are significant in the model are: $\hat{\alpha}_1$, $\hat{\alpha}_2$ *and* $\hat{\beta}_3$. Therefore, the estimated seasonal model is

$$SQRT\,\Delta\widehat{X}_t = \widehat{\alpha}_1 \cos \omega t + \widehat{\alpha}_2 \cos 2\omega t + \widehat{\beta}_3 \sin 3\omega t$$

$$SQRT\Delta\hat{X}_t = -0.5071\cos\omega t - 0.2432\cos 2\omega t - 0.3088\sin 3\omega t \qquad (19)$$

The estimates of the seasonal component are obtained using equation (19). In assessing the autocorrelation and partial autocorrelation function of the error component, it was found that the error was not random. The behaviour of the autocorrelation and partial autocorrelation function suggest an autoregressive model of order one. Table 4 shows the test for significance of the model.

Table 4: Test for Significance of Parameter Estimate of the Error Component

Type	Coef	StDev	T
AR1	0.903	0.0441	20.49
Number of observations: 102			

From Table 4, the parameter estimate in the error component is significant in the model.

Hence $\hat{Z}_t = 0.903 Z_{t-1}$ (20)

The general model for the series, which consists of the estimated trend, seasonal and error component, is given as:

$$SQRT\hat{X}_t = 3.6529 - 0.5071\cos\omega t - 0.2432\cos 2\omega t - 0.3088\sin 3\omega t + 0.903 Z_{t-1} \qquad (21)$$

The model is now used to estimate inflation rates. (See table 5).

The plots of the original and estimated series of both the actual and transformed values given in Table 5 are shown in figures 6 and 7, and they show that the model fits well to the data.

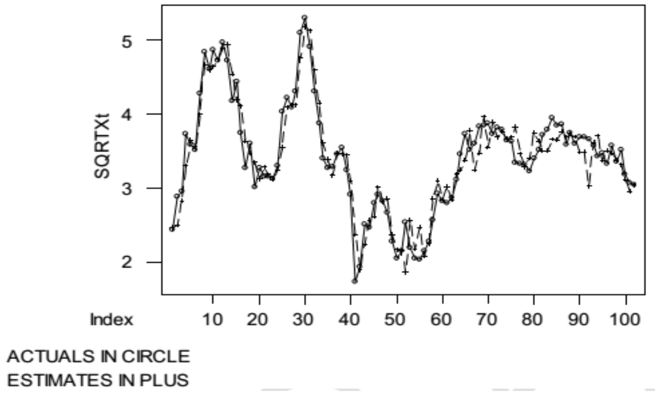

Figure 6: Plot of Actuals and Estimates of the Transformed Series

Table 5: Actuals and Estimates of Nigeria All-items Inflation Rates (2003-2011)

t	ESTSQRTXt	ESTXt	Xt	SQRTXt	t	ESTSQRT)	ESTXt	Xt	SQRTXt	t	ESTSQRT)	ESTXt	Xt	SQRTXt
1	2.45894	6.0464	5.9	2.42899	35	3.38407	11.4519	10.7	3.27109	69	3.96803	15.7453	14.8	3.84708
2	2.49951	6.2476	8.3	2.88097	36	3.17771	10.0978	10.8	3.28634	70	3.54911	12.5962	15.1	3.88587
3	2.82162	7.9615	8.7	2.94958	37	3.48145	12.1205	12	3.4641	71	3.89074	15.1378	14	3.74166
4	3.29974	10.8883	14	3.74166	38	3.45813	11.9586	12.6	3.54965	72	3.69084	13.6223	14.6	3.82099
5	3.6537	13.3495	12.9	3.59166	39	3.45463	11.9345	10.5	3.24037	73	3.76744	14.1936	14.4	3.79473
6	3.56475	12.7074	12.4	3.52136	40	3.10574	9.6456	8.5	2.91548	74	3.66179	13.4087	13.3	3.64692
7	3.99915	15.9932	18.4	4.28952	41	2.357	5.5554	3	1.73205	75	3.69333	13.6407	13.2	3.63318
8	4.68373	21.9373	23.6	4.85798	42	1.8921	3.5801	3.7	1.92354	76	3.83035	14.6716	11.2	3.34664
9	4.60276	21.1854	21.3	4.61519	43	2.2347	4.9939	6.3	2.50998	77	3.45736	11.9534	11.1	3.33167
10	4.65238	21.6446	23.8	4.87852	44	2.56834	6.5964	6.1	2.46982	78	3.29035	10.8264	11	3.31662
11	4.75027	22.5651	22.4	4.73286	45	2.61611	6.844	7.8	2.79285	79	3.40812	11.6153	10.4	3.2249
12	4.90114	24.0212	24.8	4.97996	46	3.01449	9.0871	8.5	2.91548	80	3.75526	14.102	11.6	3.40588
13	4.95641	24.566	22.5	4.74342	47	2.80696	7.879	8	2.82843	81	3.63406	13.2064	12.4	3.52136
14	4.55181	20.719	17.5	4.1833	48	2.86217	8.192	7.1	2.66458	82	3.50865	12.3106	13.9	3.72827
15	4.1966	17.6114	19.8	4.44972	49	2.36306	5.5841	5.2	2.28035	83	3.50096	12.2567	14.4	3.79473
16	4.108	16.8757	14.1	3.755	50	2.15326	4.6365	4.2	2.04939	84	3.67314	13.4919	15.6	3.94968
17	3.63175	13.1896	10.7	3.27109	51	2.15144	4.6287	4.6	2.14476	85	3.64484	13.2849	14.8	3.84708
18	3.48247	12.1276	13	3.60555	52	1.86214	3.4676	6.4	2.52982	86	3.76182	14.1513	15	3.87298
19	3.3535	11.246	9.1	3.01662	53	2.56943	6.602	4.8	2.19089	87	3.70015	13.6911	12.9	3.59166
20	3.12435	9.7616	10.7	3.27109	54	2.17886	4.7474	4.2	2.04939	88	3.7377	13.9704	14.1	3.755
21	3.28923	10.819	10	3.16228	55	2.46632	6.0827	4.1	2.02485	89	3.6965	13.6641	13	3.60555
22	3.19264	10.193	10	3.16228	56	2.07906	4.3225	4.6	2.14476	90	3.48558	12.1493	13.7	3.70135
23	3.11341	9.6933	9.8	3.1305	57	2.23993	5.0173	5.2	2.28035	91	3.4968	12.2276	13.6	3.68782
24	3.24506	10.5304	10.9	3.30151	58	2.86022	8.1808	6.6	2.56905	92	3.03385	9.2043	13.4	3.6606
25	3.55351	12.6274	16.3	4.03733	59	3.10472	9.6393	8.6	2.93258	93	3.61712	13.0835	12.8	3.57771
26	4.1022	16.828	17.9	4.23084	60	2.84175	8.0755	8	2.82843	94	3.70553	13.7309	11.8	3.43511
27	4.12568	17.0213	16.8	4.09878	61	3.01905	9.1147	7.8	2.79285	95	3.38216	11.439	12.1	3.47851
28	4.13136	17.0681	18.6	4.31277	62	2.84466	8.0921	8.2	2.86356	96	3.50707	12.2995	11.1	3.33167
29	4.75936	22.6515	26.1	5.10882	63	3.19439	10.2041	9.7	3.11448	97	3.47876	12.1018	12.8	3.57771
30	5.19483	26.9863	28.2	5.31037	64	3.2467	10.5411	12	3.4641	98	3.38236	11.4403	11.3	3.36155
31	5.14782	26.5001	24.3	4.9295	65	3.37694	11.4037	14	3.74166	99	3.32326	11.0441	12.4	3.52136
32	4.6063	21.218	18.6	4.31277	66	3.77535	14.2533	12.4	3.52136	100	3.11168	9.6825	10.2	3.19374
33	4.16304	17.3309	15.1	3.88587	67	3.24661	10.5405	13	3.60555	101	2.96192	8.773	9.4	3.06594
34	3.60814	13.0187	11.6	3.40588	68	3.47907	12.104	14.7	3.83406	102	3.04434	9.268	9.3	3.04959

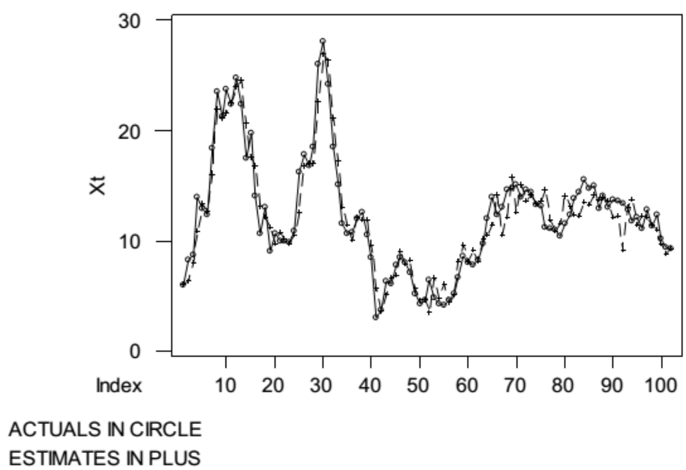

Figure 7: Plot of Actuals and Estimates of the Original Series

3.4 Forecasts for the Future Rates

Forecasts from September 2011 to September 2012 are made using the estimated general model given in equation (22). The values obtained from equation (22) are squared to give the values in table 6:

Table6: Forecasts for Future Periods

FORCAST	ACTUALS	t
9.2881	10.3	103
9.1516	10.5	104
9.2528	10.5	105
9.3567	10.3	106
9.436	12.6	107
9.4507	11.9	108
10.5905	12.1	109
11.6472	12.9	110
12.1333	12.7	111
12.7911	12.9	112
13.3627	12.8	113
12.3368	11.7	114
10.7698	11.3	115

The plot of the Actual Series and the Forecasts is given in Figure 8:

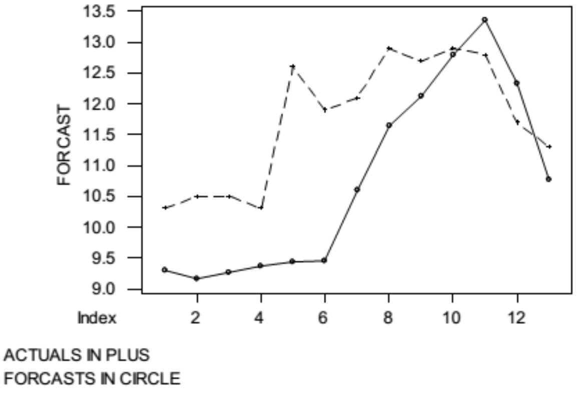

Figure 8: Plot of Actual Series and Forecasts

In assessing the adequacy of the forecast, Theil Inequality Coefficient is calculated as:

$$\frac{1}{n}\sum_{i=1}^{n}(X_i - \hat{X}_i)^2 = 3.2835, \quad \frac{1}{n}\sum_{i=1}^{n} X_i^2 = 167.67, \quad \frac{1}{n}\sum_{i=1}^{n} \hat{X}_i^2 = 174.17$$

$$U = \frac{\sqrt{3.2835}}{\sqrt{167.67} + \sqrt{174.17}} = \frac{1.81204}{26.14609} \approx 0.07$$

Since U= 0.07 is very close to zero, then the model can favourably be used to forecast the future values of inflation rates.

4.0 Discussion

The periodogram analysis reveals that there exist both short term and long term cycles within the period under study. The long term cycle is 51 months while the short term cycle is approximately 20 months. This is known by checking the second largest intensity in table 1. This goes a long way to buttress the fact that inflation is influenced by cyclical or periodic variation. It can also be deduced from the periodogram the relationship between the inflation cycle and the various government administrations within the period. Under this period of study, it is known that two administrations existed, namely Obasanjo’s and Yaradua/Jonathan’s period. The inflation cycle relates to these two administrations. The first fifty-one months represent President Olusegun Obasanjo’s period while the second cycle represents Yaradua/Jonathan’s period.

From the foregoing, it can be deduced that economic policies, activities, implementation of policies, budgets, etc. of government administration influence inflation rates in Nigeria. Most economists have confirmed that an expansionary budgetary provision among other factors helps to increase inflation rates (Dodge, 2011). A clear look at the original plot of the series shows that during Obasanjo’s period, there were higher inflation rates than the Yaradua/Jonathan’s period. This may be as a result of incessant supplementary budgets raised and the inability of the administration to follow budgetary provisions in the implementation of the budget. But the latter administration records lower inflation rates, which may be as a result of reduced passage of supplementary budgets and implementation of some reforms in the economic sectors.

5.0 Conclusion

The periodogram analysis has identified a major inflation rate cycle for the period under study to be fifty one (51) months and the former series analysis has established a former series model for the all-items inflation rates to be

$$SQRT\hat{X}_t = 3.6529 - 0.5071\cos\omega t - 0.2432\cos 2\omega t - 0.3088\sin 3\omega t + 0.903Z_{t-1}$$

This model is used to make good forecasts of inflation rates. Therefore Fourier series models can also be used to model inflation rates because of its advantage of identifying inflation cycles in addition to establishing a suitable model for the series.

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