GLOBAL JOURNAL OF MATHEMATICAL SCIENCES VOL. 5, NO. 1, 2006: 17- 24
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STOCHASTIC MODELING OF INFLATION IN NIGERIA

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(Received 17 November, 2005; Revision Accepted 4 April, 2006)

ABSTRACT

In this paper, we adopt a time series approach in modeling inflation in Nigeria using a four-decade data (1960- 1999) on consumer price index. Logarithmic transformation was used to stabilize the variation in the data. On the whole four decades, a quadratic trend was obtained. This is also true with the individual decades except in the first where a linear trend proved better than the quadratic trend. For the four–decade, the seasonal indices in the first and the last quarters of the year negatively affected the price index, whereas the second and the third quarters have positive influences. This pattern is consistent with the data relating to the first and third decades. Seasonal multiplicative ARIMA (p,d,q) x $(P,D,Q)_s$ models were fitted to first, the four decades and then to each of the decade's data. Forecasts using the models were obtained.

KEYWORDS: Buys-Ballot table; Quadratic trend; Seasonal multiplicative model, consumer price index.

1. INTRODUCTION

Government statisticians and accountants measure and record the levels of domestic output, national income and prices of the economy. Usually, they take into consideration, among others, consumption, investment, government purposes, net exports, real Gross Domestic Product (GDP), national income, and the price level. The importance of this exercise to any nation cannot be over-emphasized. For sure, with such information in hand the country can gauge her economic health [McConnell & Brue (1986)].

For the purposes of this paper, we shall discuss one aspect of these indicators –Price level measurement- which is very significant in measuring inflation and deflation in a country. It is very important to know how much the price level has changed, if at all, from one period to another. That is, we must be aware of whether and to what extent inflation (a rising price level) or deflation (a falling price level) has occurred.

Usually price level is expressed as an index number and is called price index. A price index measures the combined price of a particular collection of goods and services, called a "market basket" in a specific period relative to the combined price of an identical or similar group of goods and services in a reference period. This point of reference or bench mark is called the "base year". Mathematically, the price index in a given year becomes:

$$Price\ Index = \frac{Cost\ of\ market\ basket\ in\ a\ specific\ year}{Cost\ of\ the\ same\ market\ basket\ in\ the\ base\ year}\ x\ \frac{100\%}{1} \qquad (1.1)$$

This means that the price index in a given year can be obtained by multiplying the ratio between the specific year and the base year by 100.

In Nigeria, the Federal Government, through the Federal Office of Statistics (F.O.S.), computes indices of the prices of several different collections or market baskets of goods and services. The best known of these indices being the Consumer Price Index (C.P.I.). As the name implies, CPI measures the change in the price of a large group of items purchased by consumers. The CPI serves several major functions. It allows consumers to determine the degree to which their purchasing power is being eroded by price increases [Lind & Mason (1996)]. In that respect, it is a yardstick for revising wages, pensions, and other income payments to keep pace with changes in price.

Another major function of Consumer Price Index is that it is an economic indicator of the rate of inflation in any country. Inflation is a persistent increase in the average price level in the economy. It is measured by the inflation rate, the annual percentage change in a price index such as the Consumer Price Index or Gross Domestic Product price deflator. Inflation is the most common phenomenon associated with price level (AmosWEB Encyclonomic WEB*pedia(2000-2006)). General inflation is referred to as a rise in the general level of prices. Rates of inflation are mainly obtained from Consumer Price Index values. For instance, if we want to know how much prices have increased over the last 12 months (which is the commonly published inflation rate number) we would subtract last year's consumer price index from the current index and divide by last year's number and the result expressed in percentage by multiplying by 100. Therefore the formula for computing the Inflation Rate can be symbolically expressed as:

$$Inflation\ rate = \left(\frac{Y - X}{X}\right) x\ 100 \qquad (1.2)$$

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where Y = the current year's consumer price index; and X = the last year's consumer price index (" Inflation " Online.<http://inflationdata.com/Inflation/Articles/CalculateInflation.asp February, 2006) The CPI is computed using the Laspeyre's method [Kapadia and Anderson (1987)], where costs are computed using quantities from the base year. From the foregoing, one could then appreciate why this paper is based principally on the study of Consumer Price Index values.

Consequently, we have extracted from the Federal Office of Statistics, a forty–year data (on monthly basis) on consumer price index in Nigeria, with a view to understanding its pattern, fitting a model to it and making some statistical and economic predictions using time series approach. Section 2 considers a preliminary analysis of the data with a view to understanding the trend and seasonal components of the data. In Section 3, a detailed seasonal multiplicative ARIMA (integrated autoregressive moving average) modeling is carried out. The ARIMA model obtained is used in Section 4 to obtain price indices that will consequently lead to obtaining inflation rates for the current decade.

2. PRELIMINARY ANALYSIS

According to Wei (1990), the analysis of seasonal time series with periodicity, s, (length of the periodic interval) requires the arrangement of the series in a two- dimensional table called Buys-Ballot table after Buys-Ballot (1847). This brings out the within –periods and between-periods relationships. Within-periods relationships represent the correlation among $\ldots, X_{t-2}, X_{t-1}, X_t, X_{t+1}, X_{t+2}, \ldots$, and the between-periods relationships represent the correlation among $\ldots, X_{t-2s}, X_{t-s}, X_t, X_{t+s}, X_{t+2s}, \ldots$. In general, the within-periods relationships represent the non-seasonal part of the series while the between-periods represent the seasonal part. Furthermore, Iwueze and Nwogu (2004), Iwueze and Ohakwe (2004) and Iwueze and Nwogu (2005) have developed an estimation procedure based on the row and column averages of the Buys-Ballot table for the parameters of the trend-cycle component and the seasonal indices.

We shall denote the original data by Y_t, t = 1, 2, 3, ..., 480. Arranging Y_t in a Buys-Ballot (1847) table (Appendix I), we observe the following: (i) Marked trend as assessed by the periodic/yearly averages; (ii) Little seasonal variation as assessed by the monthly averages; (iii) Unstable variance as assessed by both the periodic and monthly standard deviations.

Appendix I: Buys-Ballot table for the consumer price index (January 1960 – December 1999)

YEAR	MONTH												MEAN	STD
	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.		
1960	7.5	7.1	7.1	7.1	7.2	7.3	7.4	7.3	7.2	7.2	7.2	7.3	7.24	0.12
1961	7.4	7.5	7.5	8.0	7.6	7.8	7.9	7.8	7.7	7.7	7.7	7.7	7.69	0.17
1962	7.5	7.9	8.0	8.1	8.2	8.4	8.4	8.2	8.1	7.9	7.8	7.8	8.03	0.26
1963	7.9	7.8	7.8	7.9	7.9	8.0	7.9	7.8	7.8	7.8	7.8	7.8	7.85	0.07
1964	7.8	7.8	7.8	7.8	8.0	8.1	8.1	8.0	8.0	7.9	7.9	7.9	7.93	0.11
1965	8.0	8.1	8.1	8.2	8.4	8.3	8.4	8.3	8.3	8.2	8.2	8.3	8.23	0.12
1966	8.5	8.5	8.7	9.0	9.3	9.6	9.4	9.3	9.2	9.2	8.9	8.8	9.03	0.36
1967	6.8	8.8	8.7	8.8	8.8	8.9	8.8	8.8	8.7	8.5	8.3	8.4	8.53	0.57
1968	8.5	8.5	8.5	8.5	8.7	8.7	8.7	8.6	8.7	8.7	8.8	8.9	8.65	0.13
1969	9.0	9.1	9.2	9.3	9.5	9.8	9.7	9.6	9.7	9.7	9.7	9.9	9.52	0.29
1970	10.3	10.3	10.4	10.7	10.9	11.0	11.0	11.0	11.2	11.0	11.1	11.2	10.84	0.33
1971	11.6	11.8	12.0	12.1	12.6	13.1	13.5	12.8	12.8	12.9	12.8	12.9	12.58	0.57
1972	12.9	13.2	13.3	13.0	13.5	13.4	13.1	12.6	12.5	13.8	12.4	12.4	13.01	0.46
1973	12.6	13.1	13.1	13.4	13.7	14.0	14.0	13.9	13.6	13.6	13.6	13.6	13.52	0.41
1974	14.7	14.7	14.8	15.5	15.3	15.3	15.7	15.6	15.8	15.6	16.0	16.1	15.43	0.48
1975	17.1	18.1	18.9	19.3	20.5	21.3	21.5	21.9	22.0	22.0	22.6	23.1	20.69	1.91
1976	23.9	24.6	24.2	24.4	24.6	25.0	25.1	25.6	25.6	26.3	25.5	25.1	24.99	0.69
1977	27.1	26.6	27.5	28.3	29.6	30.7	31.7	32.8	31.8	32.2	33.0	34.0	30.44	2.54
1978	31.0	32.1	32.9	33.7	35.0	35.4	35.2	35.3	35.5	35.9	35.8	36.1	34.49	1.67
1979	35.7	36.8	37.5	38.3	39.1	39.4	39.4	39.1	39.1	39.1	39.2	39.1	38.48	1.19
1980	39.5	39.8	39.6	39.8	40.0	40.3	44.3	45.1	44.3	44.7	45.5	45.4	42.36	[illegible]
1981	47.1	48.0	48.6	50.1	50.5	51.3	52.7	56.1	53.2	53.1	53.2	53.3	51.43	2.65
1982	53.4	53.7	53.9	54.2	54.6	54.9	55.4	55.5	55.8	56.2	56.8	57.0	55.12	1.20
1983	53.0	58.8	61.5	62.7	64.8	66.5	69.7	71.5	72.3	74.1	76.0	79.1	67.50	7.67
1984	80.9	80.6	84.5	100.0	97.7	98.1	100.4	103.6	104.5	100.9	98.6	97.0	95.57	8.53
1985	99.2	98.8	101.4	102.1	101.5	101.8	100.2	100.3	99.3	99.2	98.5	98.0	100.02	1.40
1986	96.8	98.9	97.9	98.5	102.9	104.8	108.3	111.6	112.1	110.6	111.2	111.4	105.42	6.14
1987	112.0	111.8	112.1	112.3	113.5	114.2	116.4	117.3	119.3	120.6	122.1	122.2	116.15	4.06
1988	146.7	155.8	160.4	172.1	180.7	185.4	194.1	196.6	197.7	191.9	196.5	197.0	181.24	18.20
1989	220.3	233.0	251.4	270.6	281.4	297.3	290.1	287.8	286.6	285.1	283.9	285.0	272.71	24.52
1990	282.5	285.4	287.1	291.8	296.8	298.5	300.5	300.8	294.5	292.5	295.3	295.3	293.42	5.85
1991	293.4	305.6	307.0	316.7	323.4	336.3	338.7	345.5	341.5	345.1	348.2	363.1	330.37	20.94
1992	377.8	385.9	406.8	437.0	457.4	499.3	518.6	531.5	528.6	526.6	530.8	540.3	478.40	62.00
1993	566.2	596.1	634.0	677.0	739.2	780.6	808.9	824.2	837.5	836.1	851.6	871.3	751.90	107.20
1994	893.2	943.4	955.5	1020.3	1061.0	1105.1	1185.4	1288.0	1341.5	1375.1	1459.9	1540.1	1180.70	217.00
1995	1599.2	1678.3	1732.3	1887.9	2004.2	2094.9	2164.3	2240.6	2278.9	2222.6	2252.7	[illegible]	[illegible]	256.80
1996	2359.9	2402.6	2458.2	2489.0	2626.4	2599.2	2802.9	2839.1	2818.0	2770.0	2722.7	2668.8	2629.70	168.93
1997	2697.7	2723.4	2830.7	2843.4	2885.2	2929.0	3012.3	2941.1	2860.8	2856.4	2837.5	2941.4	2863.20	89.60
1998	2935.7	2946.4	2990.6	3061.2	3095.2	3204.7	3296.3	3282.2	3211.3	3211.4	3263.2	3291.8	3149.20	136.80
1999	3355.1	3370.0	3395.7	3415.6	3446.8	3469.9	3427.5	3307.2	3283.1	3258.8	3261.8	3299.2	3357.60	74.40
MEAN	414.63	422.47	432.38	443.72	458.04	468.39	482.30	483.75	481.10	478.41	481.76	489.94	461.50	932.7
STD	876.36	885.89	903.76	916.67	941.28	957.10	982.45	975.33	965.08	958.19	961.79	976.30		

* Standard deviation (STD)

In order to stabilize the variance, we adopt Bartlett's (1947) transformation that will also help us to make the seasonal effect additive, and to make the data normally distributed. Bartlett's method is achieved by plotting the logarithm of the means against the logarithm of the standard deviations and the slope of the linear relationship obtained, is used to determine the nature of the transformation to be adopted. In our own case a slope of 1.17 was obtained using the periodic means and the standard deviations, which suggests a logarithmic transformation. Again, using the monthly means and standard deviations we had a slope of 0.67, which is approximately 1, thereby confirming the logarithmic transformation, as suggested in Bartlett (1947) [see, Osborne (2002), Ogbonna and Haris (2003) for more recent work on Bartlett's method]

Consequently, we define a new series X_t, t = 1, 2, 3..., 480, as

$$X_t = \log_e Y_t \qquad (2.1)$$

A plot of X_t suggests either a quadratic or exponential trend curve, so we explore only the curves suggested by the plot in our descriptive analysis. Using Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Square Deviation (MSD) [see Iwueze and Nwogu (2004)] as criteria for choice between the two trend curves, we obtain the results in Table 1.

Table 1: Summary of trend accuracy measures

TREND	MAPE	MAD	MSD
Quadratic	2.744	0.119	0.026
Exponential	4.586	0.168	0.050

Based on the results shown in Table 1, the quadratic trend curve appears better than the exponential trend, with the trend curve estimated by

$$M_t = 2.016 - 0.000591t + 0.0000299t^2 \qquad (2.2)$$

This means that the rate of change of price with respect to time is not constant but rather a function of the time factor. More so, the trend is non-linear with one point of stable equilibrium since the second derivative of Equation (2.2) is greater than zero. With respect to Equation (2.2), the constant 2.016 is the t-intercept at the origin; -0.00059 is the slope of the line that indicates the monthly rate of change of the consumer price indices; while 0.0000299 is the degree to which the curve changes direction.

Since one of the reasons for transformation is to make the seasonal effect additive, the transformed series, for the purposes of time series decomposition, becomes:

$$X_t = M_t + S_t + Z_t \qquad (2.3)$$

where M_t is the trend; S_t is the seasonal component; and Z_t is the irregular component.
Using the de-trended series, the following seasonal indices shown in Table 2 were obtained:

Table 2: Monthly seasonal indices for the overall data (1960 – 1999)

S/N $[i]$	1	2	3	4	5	6
MONTH	Jan.	Feb.	Mar.	Apr.	May	Jun.
Seasonal index, S	-0.0189	-0.0070	-0.0040	0.0102	0.0192	0.0257
S/N $[i]$	7	8	9	10	11	12
MONTH	JUL.	Aug.	SEPT	Oct.	Nov.	Dec.
Seasonal index, S	0.0275	0.0175	0.0006	-0.0136	-0.0262	-0.0312

The de-trended and de-seasonalized series (Irregular component, Z_t) was however, not found to be a purely random process since its sample autocorrelation coefficients, r_k, depict non-randomness (the values of r_k do not come down to zero except for very large values of the lag) as shown in Figure 1 and Table 3. Hence, we have to fit a probability model to the irregular component in Section 3. The above procedure was repeated for the individual decades using the transformed series, X_t, and the results obtained are summarized in Table 4.

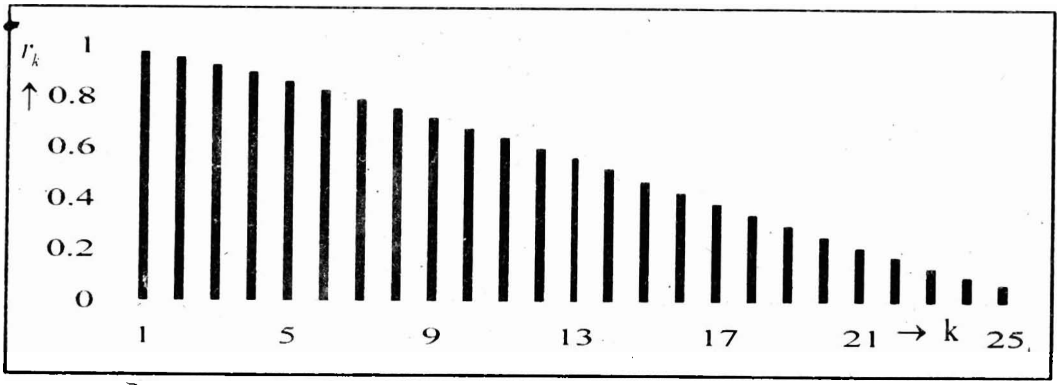

Figure 1: Plot of the sample autocorrelation function of the irregular component, Z_t.

Table 3. Sample autocorrelation function for Irregular Component of Equation 2.3

k	1	2	3	4	5	6	7	8	9	10	11	12	13
r_k	0.97	0.95	0.92	0.89	0.86	0.82	0.79	0.75	0.71	0.67	0.63	0.59	0.55
k	14	15	16	17	18	19	20	21	22	23	24	25	
r_k	0.51	0.47	0.42	0.38	0.34	0.29	0.25	0.21	0.17	0.13	0.10	0.06	

Considering Table 4, we observe that the trend for the second, third, fourth, and the overall decades was each quadratic while the first was linear. Again the seasonal effects for the first, third, and the overall were similar as the first and last quarters lead to the reduction in the price index. For the second decade, the seasonal effects in January, February ,September, October, November and December reduce the price index, whereas for the fourth decade they were negative in September, October, November and December.

Table 4: Summary of time series decomposition of X_t.

CHARACTERISTICS	DECADES				
	I	II	III	IV	OVERALL
TREND:					
Polynomial	Linear	Quadratic	Quadratic	Quadratic	Quadratic
Equation	$M_t = 1.986 + 0.00204t$	$M_t = 2.327 + 0.0067t + 0.000048t^2$	$M_t = 3.738 + 0.0082t + 0.000060t^2$	$M_t = 5.171 + 0.0437t - 0.000149t^2$	$M_t = 2.016 - 0.00059t + 0.0000299t^2$
SEASONALS:					
January	-0.00865	-0.01000	-0.02880	0.00510	-0.01890
February	-0.00432	-0.00090	-0.01720	0.00410	-0.00700
March	-0.00545	0.00140	-0.00960	0.00250	-0.00400
April	0.00616	0.00770	0.01410	0.01410	0.01020
May	0.01343	0.02320	0.01540	0.02370	0.01920
June	0.02277	0.02800	0.01680	0.02950	0.02570
July	0.02262	0.02270	0.02710	0.03470	0.02750
August	0.00729	0.00630	0.02980	0.02230	0.01750
September	0.00358	-0.00840	0.01070	-0.00570	0.00060
October	-0.01325	-0.00850	-0.00860	-0.03340	-0.01360
November	-0.01736	-0.02740	-0.01830	-0.04680	-0.02620
December	-0.01966	-0.03400	-0.03130	-0.05010	-0.03120

3. ARIMA MODELING

The descriptive analysis of Section 2 did not produce a model whose irregular component is random. We therefore need a probability model that takes account of the trend and seasonal components of the series. Such series are analysed [Box and Jenkins (1976)] by the seasonal multiplicative ARIMA (p,d,q) x $(P,D,Q)_s$ time series model: given by

$$\phi_p(B)\Phi_P(B^s)W_t = \lambda_0 + \theta_q(B)\Theta_Q(B^s)e_t \qquad (3.1)$$

where

$$W_t = (1-B)^d(1-B^s)^D X_t \qquad (3.2)$$

$$\phi_p(B) = 1-\phi_1 B - \phi_2 B^2 - \ldots - \phi_p B^p \qquad (3.3)$$

$$\theta_q(B) = 1-\theta_1 B - \theta_2 B^2 - \ldots - \theta_q B^q \qquad (3.4)$$

$$\Phi_P(B^s) = 1-\Phi_1 B^s - \Phi_2 B^{2s} - \ldots - \Phi_P B^{Ps} \qquad (3.5)$$

$$\Theta_Q(B^s) = 1-\Theta_1 B^s - \Theta_2 B^{2s} - \ldots - \Theta_Q B^{Qs} \qquad (3.6)$$

and e_t is the zero mean purely random process with constant variance $\sigma^2 < \infty$; $(1-B)^d$ is the regular differencing operator to remove the stochastic trend; $(1-B^s)^D$ is the seasonal differencing operator to remove the seasonal variation. Equations (3.3) through (3.6) are polynomials of B or B^s with no common roots but with roots that lie outside the unit circle. The parameter λ_0 represents the deterministic trend when $E(W_t) \neq 0$.

The frequency with which data are recorded determines the value assigned to seasonal period, s. In this work the data were collected on monthly basis and with twelve months in a year, our s = 12. From our preliminary analysis, the trend was found to be quadratic. Therefore, removing the trend entails differencing the series twice. Hence, our d = 2. We further differenced the de-trended series once to remove the seasonal effect, hence D = 1. The autocorrelation function $\{r_k\}$ of the de-trended, de-seasonalized series, W_t, given by Equation (3.2), is given in Table 5. Using Appendix A9.1 of Box and Jenkins (1976, p329), it is clear that p = P = Q = 1 and the seasonal model for consideration is the model

$$W_t = \lambda_0 + (1-\theta_1 B - \theta_2 B^2 - \ldots - \theta_q B^q)(1-\Theta_{12} B^{12})e_t \qquad (3.7)$$

Table5: Autocorrelation function of $W_t = (1-B)^2(1-B^{12})X_t$

lag k	r_k	lag k	r_k	lag k	r_k	lag k	r_k	lag k	r_k
1	-0.60	9	-0.02	17	0.04	25	0.07	33	-0.02
2	0.10	10	-0.02	18	-0.04	26	-0.06	34	0.00
3	-0.02	11	0.27	19	0.06	27	0.02	35	-0.02
4	0.05	12	-0.47	20	-0.06	28	0.03	36	0.03
5	-0.02	13	0.27	21	0.02	29	-0.04	37	-0.05
6	0.03	14	-0.02	22	-0.02	30	0.00	38	0.05
7	-0.05	15	0.00	23	0.05	31	0.00	39	-0.04
8	0.02	16	-0.04	24	-0.07	32	0.05	40	0.01

Our choice of q was based on the randomness of the residuals by comparing the autocorrelation function of the estimated residuals with $\pm 2/\sqrt{N}$ [Chatfield (1980)], where N is the number of observations used for estimation. Since $\overline{w} = -0.0002$, S_w = 0.0642, [where w refers to the model in equation (3.2)], For our own case, N = 466 and the t-value of $\overline{w}$ is $-0.0002/(0.0642/\sqrt{466})$ = -0.07, which is not significant. Based on these criteria, the optimal value of q is 2, leading to the model

$$(1-B)^2\left(1-B^{12}\right)X_t = \left(1-1.0999B+0.2097B^2\right)\left(1-0.9110B^{12}\right)e_t \qquad (3.8)$$

with $\hat{\sigma}^2 = 0.0009$

The ARIMA modeling procedure was repeated for the individual decades on the transformed series X_t and the results obtained are summarized in Table 6, where the values in parenthesis below the parameter estimates are the associated standard errors.

Table 6: Summary of ARIMA (p,d,q) x (P,D,Q)$_s$ models (s = 12)

Model	DECADES				
	I	II	III	IV	OVERALL
Type	$(0,1,1)\times(0,1,1)_s$	$(0,2,2)\times(0,1,1)_s$	$(0,2,1)\times(0,1,1)_s$	$(0,2,1)\times(0,1,1)_s$	$(0,2,2)\times(0,1,1)_s$
Fsti-Mates	$\hat{\theta}_1 = 0.5267$ (± 0.0835) $\hat{\Theta}_{12} = 0.7757$ (± 0.0668) $\hat{\sigma}^2 = 0.0014$	$\hat{\theta}_1 = 1.2318$ (± 0.0420) $\hat{\theta}_2 = -0.2858$ (± 0.0400) $\hat{\Theta}_{12} = 0.8387$ (± 0.0840) $\hat{\sigma}^2 = 0.0008$	$\hat{\theta}_1 = 0.8677$ (± 0.0512) $\hat{\Theta}_{12} = 0.6683$ (± 0.1012) $\hat{\sigma}^2 = 0.0013$	$\hat{\theta}_1 = 0.7400$ (± 0.0648) $\hat{\Theta}_{12} = 0.8707$ (± 0.0743) $\hat{\sigma}^2 = 0.0004$	$\hat{\theta}_1 = 1.0999$ (± 0.0457) $\hat{\theta}_2 = -0.2097$ (± 0.0462) $\hat{\Theta}_{12} = 0.9110$ (± 0.0294) $\hat{\sigma}^2 = 0.0009$

From Table 6, there are different models for the different decades, which highlight the unstable nature of prices in Nigeria. Therefore, for a good forecast we shall use the model preceding the current decade. Hence, the model describing Decade 4 would be used from this point in our analysis.

4. FORECASTING

Following the unstable nature of price level in the country and the fact that its rate of change is not constant but a function of the time factor, it is not advisable to forecast beyond one year. Therefore, using the model for the fourth decade data,

$$(1-B)^2\left(1-B^{12}\right)X_t = \left(1-0.7400B\right)\left(1-0.8707B^{12}\right)e_t \qquad (4.1)$$

we obtain the forecast for the year 2000 as shown in Table 7. It is important to note that the 95% confidence limits of our forecasts in Table 7 contain all the actual values. This undoubtedly justifies our model.

From the foregoing, it follows that as new values come on board, they should be added to obtain a new model, for forecasting to be reasonable. Since the actual values of price indices for the years 2000, 2001; 2002, 2003 and up to November 2004 are now available, we subsequently update the fourth decade data with each year's transformed values of the price indices; repeat the whole process of Section 2 for each set; and respectively develop a new model as in Section 3. Interestingly, the 95% confidence limits of the forecasts using each new model accommodate the actual values of the next year's data.

Table 7: Forecasts for transformed consumer price index values in 2000.

Month	Forecast Value	95%Confidence limit		Actual value*	Forecast Error	Percent Forecast Error
		Lower	Upper			
Jan	8.1035	8.0640	8.1431	8.0931	-0.0104	-0.1285
Feb	8.1126	8.0489	8.1762	8.1052	-0.0074	-0.0913
Mar.	8.1232	8.0356	8.2107	8.1159	-0.0073	-0.0899
April	8.1440	8.0317	8.2564	8.1356	-0.0084	-0.1032
May	8.1627	8.0244	8.3010	8.1667	0.0040	0.0490
June	8.1791	8.0135	8.3446	8.2089	0.0298	0.3630
July	8.1957	8.0017	8.3898	8.2041	0.0084	0.1024
Aug.	8.1906	7.9667	8.4144	8.2270	0.0364	0.4424
Sept.	8.1719	7.9170	8.4267	8.2408	0.0689	0.8361
Oct.	8.1555	7.8685	8.4426	8.2468	0.0913	1.1071
Nov.	8.1527	7.8322	8.4731	8.2331	0.0804	0.9765
Dec.	8.1628	7.8078	8.5178	8.2371	0.0743	0.9020

* Actual values as obtained from the original data from F.O.S.

For want of space, we shall only consider in detail the transformed series from January1990 to November 2004 so as to forecast the consumer price indices for 2005. Decomposing the time series, X_t (t = 1, 2, 3... 178,179), the trend is found to be quadratic with the equation,

$$M_t = 5.275 + 0.0389t - 0.0001t^2 \quad (4.2)$$

The seasonal indices in the first and last quarters of the year *negatively affected the consumer price index,* whereas the second and the third quarters have positive influences. Finally, the appropriate seasonal multiplicative ARIMA(p,d,q)x (P,D,Q)s model becomes:

$$(1-B)^2(1-B^{12})X_t = (1-0.7953B)(1-0.8645B^{12})e_t \quad (4.3)$$

Using the model, we now proceed to forecast the 2005 consumer price index values starting from December 2004 and obtained the result shown in Table 8.

Table 8: Forecasts for transformed consumer price index values (Dec. 2004 – Dec. 2005)

Year	Month	Forecast Value	95 % Confidence limit	
			Lower	Upper
2004	Dec	8.8100	8.7694	8.8506
2005	Jan.	8.8280	8.7644	8.8916
	Feb	8.8429	8.7573	8.9285
	Mar.	8.8513	8.7434	8.9591
	April	8.8837	8.7529	9.0144
	May	8.9107	8.7562	9.0652
	June	8.9342	8.7552	9.1133
	July	8.9651	8.7605	9.1696
	Aug.	8.9692	8.7383	9.2002
	Sept.	8.9789	8.7207	9.2371
	Oct.	8.9802	8.6938	9.2665
	Nov.	8.9893	8.6739	9.3047
	Dec.	9.0035	8.6560	9.3511

5. CONCLUSION

From a 45-year data (1960-2004) on consumer price index obtained from the then Federal Office of Statistics, we critically examined four decades. A Preliminary analysis done, showed that the decades behaved differently. Consequently, different models were fitted to each of the decades. The model for the fourth decade (1990 – 1999) was adopted in forecasting the consumer price index for its next year, 2000. The 95% confidence limits of the forecast contain the actual values.

The actual consumer price index values from 2000 to November 2004, now available, were used to update the fourth decade data. Analyses were then made based on the new series. The trend was found to be quadratic and the seasonal multiplicative
ARIMA(0,2,1)x(0,1,1)$_{12}$ model was used to forecast the consumer price index values for 2005, and results shown in Table 8.

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