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Time Series Analysis Of Monthly Sales Of Petroleum Products (A Case Study Of Nigerian National Petroleum Corporation, Nnpc – Enugu, From 1996 – 2003)

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Abstract: - Time series is the name given to the values of some statistical variables measured over a uniform set of time points which may represent the historical performance of some economic or business variable. Examples of time series are total monthly sales receipts in a departmental store, total monthly sales of petroleum products, total monthly production by company, and consumption of electricity in kilowatts data on population motor registration. This research work is focused on investigating the monthly sales of petroleum products by Nigerian National Petroleum Corporation for the past eight years (1996 to 2003) and to construct an autoregressive model of a suitable order for the process.

Keyword: - *Electricity, Time series Model, Stochastic Model, Crude oil, Economy*

I. INTRODUCTION

The search of oil in Nigeria started as early as 1937, but the discovery was not until 1956. The sole of petroleum products began in December 1957, managed by a consortium of Royal Dutch Shell and British Petroleum BP Now known as Shell Petroleum Development Company SPDC.

G.A, Aga (1993) stated that Nigeria was the second oil producing nation in Africa after Libya and sixth in the world. In May 1971, the Nigeria National Oil Company was established under the company and Allied matter Act of 1958 as applicable then. NNOC was the government Agency Mandated by law to engage in all phases of oil production and sales, NNOC was later in 1977 amalgamated into a full flex ministry of petroleum to form the Nigeria National Petroleum Corporation (NNPC), which is in partnership with several oil company from different countries operating in Nigeria. Before October 1965, Nigeria Crude Oil was refined overseas and all the processed oil needs were imported. The first refinery plant came into operation in 1965 located at Alesa Eleme near Port-Harcourt. Later Warri and Kaduna Petro-chemical refineries were established in 1978 and 1980 respectively. Similarly, Pipeline and Products Marketing Company Ltd (PPMC) Enugu Depot was commissioned in 25 August 1975 by the then military Governor of the old Anambra State; Colonel D.S. Abubakar.

The last was the second refinery in Port-Harcourt. It is however worthy to note that NNPC has several subsidiary company e.g. Pipeline and Product Marketing Company (PPMC).

II. NIGERIAN NATIONAL PETROLEUM CORPORATION (ITS ROLE IN SALE OF PETROLEUM PRODUCTS)

The NNPC's role in Oil Industry is so much that it cannot handled it alone. This is the reason for the establishment of subsidiary company like pipeline and Products Marketing Company Ltd (PPMC).

The Nigerian National Petroleum Corporation manages the affairs of the oil industry in Nigeria, while the PPMC under the corporation is in charge of sales of petroleum products.

Government policy on oil matter such sales is been conveyed by the Petroleum Products Price Regulatory Agency (PPPRA) currently headed by Alhaji Gbalamosi. NNPC therefore, works in conjunction with PPPRA to implement government policy such as prices of petroleum products. Nigerian National Petroleum Corporation carries out its function as such in both local and international.

III. STATEMENT OF PROBLEM

Over the years, the frequent review of prices of petroleum products has gain a space in the heart of Nigerians, and most of the time, the out of stock of petroleum products at depot for sales is also rampart. In view of the above statement, the project examines total monthly sales of petroleum products in Nigeria National Petroleum Corporation in Enugu State and build a stochastic model for the data obtained.

IV. OBJECTIVES OF STUDY

1. To determine the stationarity of sales of petroleum products.

2. To construct an autoregressive model of a suitable order for the process.
3. To forecast the series for sales in 2004 quarters.
4. To make recommendation based on the findings of the research

V. LITERATURE REVIEW

In view of that fact that it is necessary to upgrade standard in other to meet the text of time and improved models on ground. The researcher is poised to consolidate on the work done by some researchers in the past on related topics. This research work therefore, reviews the works of past researchers and their reports as contained in textbooks, Newspapers, Bulletin and Journals on sales of petroleum products in Nigeria.

Prof Jubril Aminu, Hon Minister of Petroleum Resources (1990) saw the sales of petroleum products as a function of production since research is abundant. He emphasized that investment has been low in all OPEC nations and Nigeria in general. He stress that unless we increase our investment, production would decline and this would adversely affect sales.

Dr. T.M John (1990) in his speech said that "there is too much waste in NNPC, the management style and habits are most wasteful". He emphasized that waste abounds in NNPC namely at the plants, in projects and in support services. He said in NNPC we replace rather than maintain and repair, we buy in excess of our requirement at prices higher than commercial average and from source capabilities lower than commercial standard.

The society's view is that the general purpose of sales of petroleum products is to add comfort to the wellbeing of mankind. The way to fulfill this purpose is to produce meaningful work for the members of the society as well to distribute adequate oil and services to the needs of member of the society.

Unfortunately, government policy of the day seems to be inimical to this concept. The frequent increases in prices of petroleum product over the year has not address the plight of the masses. It is however hoped that economic reform program embarked upon by the present administration of President Olusegun Obasanjo will meet the need and yearning of the people

VI. METHODOLOGY

This research highlights the methods used in analyzing the data, and they are:

AUTOCORRELATION FUNCTION

Considering the fact that it is usually impossible to obtain a complete description of a stochastic process (i.e. actually specifying probability distribution), the autocorrelation function provides a particular description of the process for modeling purpose. The autocorrelation function discusses how much correlation there is or how much interdependency there is between neighboring data point in the series y_t

We define the Autocorrelation with lag k as

$$p_k = \frac{E((y-y_t)(y_{t+k}-y_t)}{\sqrt{E(y-y_t)^2 E(y_{t+k}-y_t)^2}}$$

$$= \frac{cov\,(y_t y_{t+k})}{\sigma_y \sigma_{y+k}}$$

For a stationary process, the variance at time t is the same as the variance at time $t+k$ hence, the denominator is just the variance of the stochastic process and

$$p_k = \frac{E((y-y_t)(y_{t+k}-y_t)}{\sigma_y \sigma_{y+k}}$$

The numerator is the covariance between$y_t and y_{t+k}$, Υ_k

Thus,

$P_k = \Upsilon_k \quad \Rightarrow Po \quad = \Upsilon_0 = 1$ for any stochastic process

Suppose that the stochastic process is $y_t = \sum_t$

Where $\sum_t$ is an independently distributed random variable with zero mean.

The autocorrelation function for this process given is called a White Noise and there is no model that can provide a forecast any better than y_{t+l} = 0 for all L

Thus if the autocorrelation function P_k is zero (or close to zero) for all K > 0, there is little or no value in using a model to forecast the series.

The autocorrelation function P_k is theoretical and in practice, an estimate of the autocorrelation function called the sample autocorrelation function.

$$\boldsymbol{p_k = \frac{\sum_{t=1}(y - y_t)(y_{t+k} - y_k)}{\sum_{t=1}^{t-k}(y - y_t)^2}}$$

AUTOREGRESSIVE MODELS

The autoregressive process of order P in the current observation. It is generated by a weighted average of Past observations going back P periods, together with a random in the current period denoted by AR (P) and with equation as:

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \delta + \Sigma_t$$

Where δ Is a constant term which relates to the mean of the stochastic process?

NOTE

If the autoregressive process is stationary, then its mean is denoted by μ which must be invariant with respect to time. i.e.

$$\Sigma(y_t) = \Sigma(y_{t-1}) = \Sigma(y_{t-2}) =, \dots, \mu$$

Which can also be given by:

$\mu = \phi_1\mu + \phi_2\mu + \dots + \phi_p\mu + \delta$

Or $\mu = - \phi_I - \phi_2 - \dots - \phi_p$

The mean of the process also gives the stationarity such that the process is stationary, the mean μ must be finite and so

$\phi_1 + \phi_2 + \dots + \phi_p < 1$

To examine the properties of a simple autoregressive process we must determine the mean, variance and covariance for the process i.e. first order autoregressive process AR (I)

$$y_t = \phi_1 y_{t-1} + \delta + \Sigma_t.$$

This process has the mean

$$M = \frac{\delta}{1-\emptyset_1} \text{ Stationary if } |\emptyset| < 1$$

The variance Υ_0 about its means, assuming stationary and setting $\delta = 0$ i.e.

$$\Upsilon_0 = \frac{\sigma\Sigma^2}{1-\emptyset_1{}^2}$$

The covariance of y_t about the mean is

$$\Upsilon_1 = \frac{\Sigma(y_{t-1}(\phi y_{t-1} + \Sigma_t)}{\phi 1\ \Upsilon 0}$$

$$\Upsilon_1 = \frac{\sigma\Sigma^2}{1-\phi_1{}^2}$$

NOTE

The autocorrelation function for AR (I) begins at $P_0 = 1$ and declines geometrically

$$p_k = \frac{\Upsilon_k}{\Upsilon_0} = \phi_1{}^k$$

The second order autoregressive process AR (2)

$$y_t = \phi y_{t-1} + \Upsilon\phi_2\, y_{t-2} + \sigma + \Sigma$$

The process has mean

$$\mu = \frac{\sigma}{1 - \Upsilon\phi 1 - \phi 2}$$

And a necessary condition for stationary is that:

$\phi_1 + \Upsilon\phi_2 < 1$

The variance and covariance of y_t is measured in deviation form. That is:

$$\Upsilon_0 = \Sigma(y_t(\phi_1 y_{t-1} + \phi_2 y_{t-2} + \Sigma_t))$$
$$= \phi_1\, \Upsilon_1 + \phi_2\, \Upsilon_2 + \sigma_\Sigma{}^2$$

$$\Upsilon_1 = \Sigma(y_{t-1}\,(\phi_1 y_{t-1} + \phi_2 y_{t-2} + \Sigma_t))$$
$$= \phi_1\, \Upsilon_0 + \phi_2\, \Upsilon_1$$
$$\Upsilon_2 = \Sigma(y_{t-2}\,(\phi_1 y_{t-1} + \phi_2 y_{t-2} + \Sigma_t))$$
$$= \phi_1\, \Upsilon_1 + \phi_2\, \Upsilon_0$$

And in general for $k \geq 2$

$$\Upsilon_k = \Sigma(y_{t-k}\,(\phi_1 y_{t-1} + \phi_2 y_{t-2} + \Sigma_t))$$

$= \phi_1 \Upsilon_{k-1} + \phi_2 \Upsilon_0$

These equations can be solved simultaneously to get Υ_0 in term of ϕ_1, ϕ_2 and σ_Σ^2 such that

$$\Upsilon_1 = \frac{\phi \Upsilon_2}{1 - \phi_2}$$

NOTE

These equation can be used to derived the autocorrelation function P_k

$$P_1 = \frac{\phi_1}{1 - \phi_2} \ldots \quad (1) \qquad p_2 = \frac{\Upsilon\phi_2 + \Upsilon\phi_1^2}{1 - \phi_2} \ldots \quad (2)$$

For $K \geq 2$, $P_k = \Upsilon\phi_1 P_{k-1} + \Upsilon\phi_2 P_{k-2}$ which can be used to calculate autocorrelation function for $K > 2$

Equation (1) and (2) are called the Yule Walker equations. Suppose we know the sample autocorrelation functions for a time Series that is second – order Autoregressive process or more i.e. P_1 and P_2 or P_k could be measured and substituted in the Yule – Walker equation and solved simultaneously for the unknown ϕ_1 and ϕ_2 or ϕ_k.

The essence of Yule – Walker equations implies therefore, that they could be used to obtain estimates of the Autoregressive parameters ϕ_1 and ϕ_2 or ϕ_k.

VII. PARTIAL AUTOCORRELATION FUNCTION P.A.C.F

The partial autocorrelation function is denoted by ($\Upsilon\phi_{kk}$: K = 1, 2 . . .) the set of partial autocorrelation at various lags K are defined by.

$$\phi_{Kk} = \frac{(p_k{}^*)}{p_k}$$

Where

P_k is the k x k autocorrelation matrix and P_k^x is P_k with the last column replaced by

$$\begin{pmatrix} P_1 \\ . \\ . \\ . \\ P_k \end{pmatrix}$$

So $\phi_{11} = P_1$

$$\phi_{22} = \frac{\left[\begin{pmatrix} 1 & p_1 \\ p_1 & p_2 \end{pmatrix}\right]}{\left[\begin{pmatrix} 1 & p_1 \\ p_1 & 1 \end{pmatrix}\right]} = \frac{p_2 - p^2{}_1}{1 - p_1{}^2}$$

And an estimate ϕ_{kk} can be obtained by replacing the P_i by Υ_1. At lags large enough for the p.a.c.f to have died out Quenouille's formula gives.

$$\text{Var}(\phi_{kk}) \cong \frac{1}{N}$$

$$\text{i.e. } (\phi_{kk}) \cong \frac{1}{\sqrt{N}}$$

$$\phi_{33} = \frac{\begin{bmatrix} 1 & p_1 & 1 \\ p_1 & 1 & p_2 \\ p_2 & p_1 & \Upsilon_3 \end{bmatrix}}{\begin{bmatrix} 1 & p_1 & p_2 \\ p_1 & 1 & p_1 \\ p_2 & p_1 & 1 \end{bmatrix}}$$

Obtain the determinant of the matrix above.

Under the hypothesis of $\Upsilon\phi_{kk} = 0$, K = 1, 2 … Quenoullis formular for K > 1 distribution with mean 0 and standard deviation $\frac{1}{T}$ where, (T $\Rightarrow$ no of

Observations in the series)

Bartlett's formular provides approximately standard errors for the autocorrelations, so that the order of the moving average process can be determined from significant tests on the sample autocorrelations.

For the order of an autoregressive process, this can be obtained from the partial autocorrelation function. To understand what the partial autocorrelations functions is and how it can be used, let us consider the covariance and autocorrelation function for the autoregressive process of order P.

NOTE: The covariance with displacement K is determine from

$\Upsilon_k = \sum(y_{t-k}\ (\phi_1 y_{t-1} + \phi_2 y_{t-2} + \ldots + \Upsilon\phi_p y_{t-p} + \Sigma_t))$

Letting K = 0, 1 . . . P, we obtain the following P + 1 differences equations that can be solved simultaneously for;

$$\left.\begin{aligned} &\Upsilon_0,\ \Upsilon_1,\ \Upsilon_p \\ &\Upsilon_0 = \phi_1 \Upsilon_1 + \phi_2 \Upsilon_2 + \ldots + \Upsilon\phi_P \Upsilon_p + \sigma_\Sigma^2 \\ &\Upsilon_1 = \phi_1 \Upsilon_0 + \phi_2 \Upsilon_1 + \ldots + \Upsilon\phi_P \Upsilon_{p-1} \\ &. \\ &. \\ &. \\ &\Upsilon_p = \phi_1 \Upsilon_{p-1} + \Upsilon\phi_2 \Upsilon_{p-2} + \ldots \phi_p \Upsilon_0 \end{aligned}\right\} \text{(A)}$$

Autocorrelations $P_1 = \phi_1$. Thus, if the calculated value of $\Upsilon\phi_1$ is significantly different from zero, then the autoregressive process is at least order I, and we denote this value $\phi_1 = a_1$.

Similarly, the hypothesis that P = 2, we solve the Yule – Walker equations for P = 2 gives us a new set of estimates ϕ_1 and ϕ_2. If ϕ_2 is significantly different firm zero as well, we therefore conclude the process is at least order 2, and P = 2 is denoted by ϕ_2 as a_2.

This process can be repeated successive values P for P = 3, obtained and estimate of $\Upsilon\phi_3$ denoted by a_3. The new sets of sequence $a_1, a_2, a_3, \ldots$ are called the partial autocorrelation functions and can be used to infer the order of the autoregressive process for its behaviour. In particular, if the true order of the process is P, we should observe that aj = 0 for j > p.

For displacement to be greater than P, the covariance are determine from:

$\Upsilon_k = \phi_1 \Upsilon_{p-1} + \phi_2 \Upsilon_{k-2} + \ldots + \Upsilon\phi_p \Upsilon_{k-p}$

Now dividing both sides in (A) by Υ_0, we obtain a set of P equations that together determine the first P values of the autocorrelation function.

I.e.

$$\left.\begin{aligned} &P_1 = \phi_1 + \phi_2 P_1 + \ldots + \phi_p P_{p-1} \\ &. \\ &. \\ &. \\ &P_p = \phi_1 p_{p-1} + \phi_2 p_{p-2} + \ldots + \phi_p \\ &\text{For } K > P,\ P_k = \phi_1 P_{k-1} + \phi_2 P_{k-2} + \ldots + \phi_p P_{k-p} \end{aligned}\right\} \text{(B)}$$

NOTE

Equations (B) are the Yule – Walker equations:

If $P_1, P_2 \ldots P_p$ are known, then the equations can be solved for $\phi_1, \phi_2 \ldots \phi_p$.

Suppose we start by hypothesizing that P = 1. The equations (B) boils down to $P_1 = \phi_1$, or using the sample.

VIII. FORECASTING: USING AN AUTOREGRESSIVE MODEL

Having determine the model in which the chance element plays a dominant role in determining the structure of the model. Consider the simplest form of the Autoregressive model.

$y_t = \Upsilon\phi_1 y_{t-1} + \Sigma_t$

OR

The general form of pth order of the autoregressive process is defined by

$y_t - \phi_1 y_{t-1} - \phi_2 y_{t-2} - \ldots \phi_p y_{t-p} + \Sigma_t$

Where $\phi_1, \phi_2 \ldots \phi_p$ are constants and the model is denoted as AR (P) generally the model may be written as

$y_t = \Upsilon\phi_1 y_{t-1} + \sigma + \Sigma_t$

Where

σ And Σ_t are assume to be zero for a stationary time series.

NOTE

$\Upsilon\phi_1, \Upsilon\phi_2$ are obtained from – Yule – Walker equations

$\phi_1 + \phi_2 P_1 = P_1$

$\phi_1 P_1 + \phi_2 = P_2$

And the partial autocorrelation functions are obtained as $\phi_1 = P_1$

$$\phi_2 = \frac{\left[\begin{pmatrix} 1 & p_1 \\ p_1 & p_2 \end{pmatrix}\right]}{\left[\begin{pmatrix} 1 & p_1 \\ p_1 & 1 \end{pmatrix}\right]}$$

$$= \frac{P_2 - P_1^2}{1 - P_1^2}$$

$$\phi_2 = 0, \qquad K>1$$

$$\text{Var}(\phi_{kk}) \cong \frac{1}{N}$$

$$(\phi_{kk}) \cong \frac{1}{\sqrt{N}}$$

The forecast for the simplest case is obtained as

$$y_{t+1} = \phi_1 y_t$$

Similarly the future value y_{t+2} can be obtain as follows

$$y_{t+2} = \phi_1 y_{t+1}$$

$$y_{t+2} = \phi^2 y_t$$

Thus, the general form is

$$y_{t+h} = \Upsilon \phi_1^h y_t$$

TABLE 1 SALES OF PETROLEUM PRODUCTS (1996 – 2003) IN BILLION NAIRA

Month	1996	1997	1998	1999	2000	2001	2002	2003
JAN	60711101	65501003	62779811	63576009	68380201	61755364	67437076	72741486
FEB	58814721	60113216	58003462	58449975	60435178	55781770	643240661	66142083
MAR	60040001	63223741	62562201	63483375	64186064	58870795	68642359	70365536
APR	63202613	61148848	60014841	59098118	60975796	61578707	65784376	72775451
MAY	61746114	62883721	62983112	62634888	63760263	64797113	68815832	72612419
JUN	58349101	60245717	61421141	59651963	61310173	59202669	66060544	72554396
JUL	62455100	60731113	59984002	63380117	59558565	61409897	67625754	70958795
AUG	60848233	59123014	62343737	62967150	48871749	62968852	69925800	71234915
SEP	60241155	62356018	60375241	64317483	59729366	62033098	67520656	72329038
OCT	61589134	63245771	59994124	62465230	64654576	64778848	70179284	74688993
NOV	58436717	60214551	61435071	63784366	59554104	63666618	69830308	71235804
DEC	65343710	64324118	66315211	67423414	61164526	66662696	72828313	71711536
TOTAL	**73177700**	74311083	**738210236**	751272066	**732380561**	743505427	**808891963**	**85936452**

DATA PRESENTATION AND ANALYSIS

TABLE 2: SALES OF PETROLEUM PRODUCTS (MILLION NAIRA)

MONTH	1996	1997	1998	1999	2000	2001	2002	2003
JAN	60.71	65.5	62.78	63.58	68.38	61.73	67.44	72.74
FEB	58.81	60.11	58.00	58.49	60.44	55.75	64.44	66.14
MAR	60.04	63.11	62.56	63.48	64.19	68.87	68.64	70.37
APR	63.20	61.15	60.01	59.10	60.78	61.59	65.78	72.78
MAY	61.75	62.88	62.98	62.63	63.76	64.80	68.82	72.61
JUN	58.35	60.25	61.42	59.65	61.31	59.20	66.06	72.55
JUL	62.46	60.73	59.98	63.38	59.56	61.41	67.63	70.96
AUG	60.85	59.12	62.34	62.97	48.87	62.97	69.93	71.23
SEP	60.24	62.36	60.32	64.32	59.73	62.03	67.52	72.23
OCT	61.59	63.25	62.47	62.47	64.65	64.78	70.18	74.69
NOV	58.44	60.21	63.78	63.78	59.55	63.67	69.83	71.24
DEC	65.34	64.32	66.32	67.42	61.64	66.66	72.83	71.77
TOTAL	731.78	742.99	742.96	751.26	732.86	753.49	819.10	859.25
MEAN	60.98	61.92	61.91	62.61	61.07	62.79	68.26	71.60

TABLE 3: QUARTERLY SALES OF PETROLEUM PRODUCTS (MILLION NAIRA)

YEAR	QTR 1	QTR 2	QTR 3	QTR 4	TOTAL	MEAN
1996	179.56	183.30	183.55	185.37	731.78	182.95
1997	188.72	184.28	182.21	187.78	742.99	185.75
1998	183.34	184.41	182.64	192.57	742.96	185.74
1999	185.55	181.38	190.67	193.67	751.27	187.82
2000	193.01	185.85	168.16	185.84	732.86	183.22
2001	186.38	185.59	186.41	195.11	753.49	188.37
2002	200.52	200.66	205.08	212.84	819.10	204.78
2003	209.25	217.94	214.42	217.64	859.25	214.81

TABLE 4 ARRANGING THE QUARTERLY SALES DATA (IN MILLION NAIRA) IN SERIES ACCORDING TO LAG K; 0, 1, 2, 3, 4, 5

T	K = 0	K = 1	K = 2	K = 3	K = 4	K = 5
	y_t	y_{t+1}	y_{t+2}	y_{t+3}	y_{t+3}	y_{t+4}
1	179.56	183.30	183.55	185.37	188.72	184.28
2	183.30	183.55	185.37	188.72	184.28	182.21
3	183.55	185.37	188.72	184.28	182.21	187.78
4	185.37	188.72	184.25	182.21	187.78	183.34
5	188.72	184.28	182.21	187.78	183.34	184.41
6	184.28	182.21	187.78	183.34	184.41	182.64
7	182.21	187.78	183.34	184.41	182.64	192.57
8	187.78	183.34	184.41	182.64	192.57	185.55
9	183.34	184.41	182.64	192.57	185.55	181.38
10	184.41	182.64	192.57	185.55	181.38	190.67
11	182.64	192.57	185.55	181.38	190.67	193.67
12	192.57	185.55	181.38	190.67	193.67	193.01
13	185.55	181.38	190.67	193.67	193.01	185.85
14	181.38	190.67	193.67	193.01	185.85	168.16
15	190.67	193.67	193.01	185.85	168.16	185.84
16	193.67	193.01	185.85	168.16	185.84	186.38
17	193.01	185.85	168.16	185.84	186.38	185.59
18	185.85	168.16	185.84	186.38	185.59	186.41
19	168.16	185.84	186.38	185.59	186.41	195.11
20	185.84	186.38	185.59	186.41	195.11	200.52
21	186.38	185.59	186.41	195.11	200.52	200.66
22	185.59	186.41	195.11	200.52	200.66	205.08
23	186.41	195.11	200.52	200.66	205.08	212.84
24	195.11	200.52	200.66	205.08	212.84	209.25
25	200.52	200.66	205.08	212.84	209.25	217.94
26	200.66	205.08	212.84	209.25	217.94	214.42
27	205.08	212.84	209.25	217.94	214.42	217.64
28	212.84	209.25	217.94	214.42	217.64	-
29	209.25	217.94	214.42	217.64	-	-
30	217.94	214.42	217.64	-	-	-
31	214.94	217.64	-	-	-	-
32	217.64	-	-	-	-	-
TOTAL	**6133.70**					

ESTIMATION OF AUTOCOVARIANCE AND AUTOCORRELATION FOR LAGS K; 0, 1, 2, 3, 4

AUTO COVARIANCE $= \sum_{t=1}^{T-k} \frac{(y_t - y_1)(y_{t-k} - y_t)}{T}$

VARIANCE $= \sum_{t=1}^{T-k} (y_t - y_1)^2$

MEAN $= \sum \frac{y_t}{T}$

T =No of observation in the series

TABLE5: Estimation of auto covariance and autocorrelation for lag k, 0, 1,2,3,4.

		K = 0		K = 1	
T	Y_t	$Y_t - y_t$	$(Y_t - y_t)^2$	$Y_{t-k} - y_t$	$(Y_t - y_t)(Y_{t-k} - y_t)$
1	179.56	-12.12	146.89	-8.38	101.57
2	183.30	-8.38	70.22	-8.13	68.13
3	183.55	-8.13	66.10	-6.31	51.30
4	185.37	-6.31	39.82	-2.96	81.68
5	188.72	-2.96	8.76	-7.40	21.90
6	184.28	-7.40	54.76	-9.47	70.08
7	182.21	-9.47	89.68	-3.90	36.93
8	187.78	-3.90	15.21	-8.34	32.53
9	183.34	-8.34	69.59	-7.27	60.63
10	184.41	-7.27	52.85	-9.04	65.72
11	182.64	-9.04	81.72	0.59	-8.05
12	192.57	0.89	0.79	-6.13	-5.46
13	185.55	-6.13	37.58	-10.30	63.14
14	181.38	-10.30	106.09	-1.01	10.40
15	190.67	-1.01	1.02	1.99	-2.01
16	193.67	1.99	3.96	1.33	2.65
17	193.01	1.33	1.77	-5.83	-7.75
18	185.85	-5.86	33.99	-23.52	137.12
19	168.16	-23.52	553.19	-5.84	137.36
20	185.84	-5.84	34.11	-5.30	30.95
21	186.38	-5.30	28.09	-6.09	32.28
22	185.59	-6.09	37.09	-5.27	32.09
23	186.41	-5.27	27.77	3.43	-18.08
24	195.11	3.43	11.76	8.84	30.32
25	200.52	8.84	78.15	8.98	79.38
26	200.66	8.98	80.64	13.40	120.33
27	205.08	13.40	179.56	21.16	283.54
28	212.84	21.16	447.75	17.57	371.78
29	209.25	17.57	308.79	26.26	461.39
30	217.94	26.26	689.59	22.74	597.15
31	214.42	22.74	517.11	25.96	590.33
32	217.42	25.96	673.92	-	-
TOTAL	**6133.70**		**4548.20**		**3466.33**

T	K = 2 $Y_{t+k} - y_t$	$(Y_t - y_t)(Y_{t+k} - y_t)$	K = 3 $Y_{t+k} - y_t$	$(y_t - y_t)(Y_{t+k} - y_t)$
1	-8.13	98.54	-6.31	76.48
2	-6.31	52.88	-2.96	24.80
3	-2.96	24.06	-7.40	60.16
4	-7.40	46.69	-9.47	59.76
5	-9.47	28.03	-3.90	11.54
6	-3.90	28.86	-8.34	61.72
7	-8.34	78.98	-7.27	68.85
8	-7.27	28.35	-9.04	35.26
9	-9.04	72.39	0.89	-7.42
10	0.89	-6.47	-6.13	44.57
11	-6.13	55.42	-10.30	93.11
12	-10.30	-9.17	-1.01	-0.90
13	-1.01	6.19	1.99	-12.20
14	1.99	-20.50	1.33	-13.70
15	1.33	-1.34	-5.83	-5.89
16	-5.83	-11.60	-23.52	-46.80
17	-23.52	-31.28	-5.84	-7.77
18	-5.84	34.05	-5.30	30.89
19	-5.30	124.66	-6.09	143.24
20	-6.09	35.57	-5.27	30.78
21	-5.27	27.93	3.43	-18.18
22	3.43	-20.89	8.84	-53.84
23	8.84	-46.59	8.98	-47.32
24	8.98	30.80	13.40	45.96
25	13.40	118.46	21.16	187.05
26	21.16	190.02	17.57	157.78
27	17.57	235.44	26.26	351.88
28	26.26	555.66	22.74	481.18
29	22.74	399.54	25.96	456.12
30	25.96	681.71	-	-
31	-	-	-	-
32	-	-	-	-
	-	**2806.39**	-	**2218.89**

T	K = 4 $Y_{t+k} - y_t$	$(Y_t - y_t)(Y_{t+k} - y_t)$	K = 5 $Y_{t+k} - y_t$	$(y_t - y_t)(Y_{t+k} - y_t)$
1	-2.96	35.88	-7.40	89.69
2	-7.40	62.01	-9.47	79.36
3	-9.47	76.99	-3.90	31.71
4	-3.90	24.61	-8.34	52.63
5	-8.34	24.69	-7.27	21.54
6	-7.27	53.80	-9.04	66.90
7	-9.04	85.61	0.89	-8.43
8	0.89	-3.47	-6.13	23.91
9	-6.13	51.12	-10.30	85.90
10	-10.30	74.88	-1.01	7.34
11	-1.01	9.13	1.99	-17.99
12	1.99	1.77	1.33	1.18
13	1.33	-8.15	-5.83	35.74
14	-5.83	60.05	-23.52	242.26
15	-23.52	23.76	-5.84	-10.55
16	-5.84	-11.62	-5.30	-8.10
17	-5.30	-7.05	-6.09	30.72
18	-6.09	35.50	-5.27	-80.67
19	-5.27	123.95	3.43	-51.63
20	3.43	-20.03	8.84	-47.59
21	8.84	-46.85	8.98	-81.61
22	8.98	-54.69	13.40	-111.51
23	13.40	-70.62	21.16	60.27
24	21.16	72.78	17.57	232.14
25	17.57	155.32	26.26	249.11
26	26.26	235.81	27.74	347.86
27	22.74	304.72	25.96	-
28	25.96	549.31	-	-
29	-	-	-	-
30	-	-	-	-
31	-	-	-	-
32	-	-	-	-
TOTAL	**1839.21**	-	**1246.06**	

IX. COMPUTATIONS

Let the variable be denoted by

$\Upsilon_0 = \frac{4548.20}{32} = 142.13$

The auto covariance of lag k is Υ_k for k = 1, 2, 3, 4 and 5

$\Upsilon_0 = 1 = \frac{3466.32}{32} = 108.32$

$\Upsilon_0 = 2 = \frac{2806.39}{32} = 87.10$

$\Upsilon_0 = 3 = \frac{2218.89}{32} = 69.34$

$\Upsilon_0 = 4 = \frac{1839.21}{32} = 57.48$

$\Upsilon_0 = 5 = \frac{1246.06}{32} = 38.94$

Denote the autocorrelation by P_k and given by

$P_k = \frac{\Upsilon_k}{\Upsilon_0}$, for k = 0, 1, 2, 3, 4 and 5

$P_k = 0 = \frac{142.13}{32} = 1$

$P_k = 1 = \frac{108.32}{32} = 1$

$P_k = 2 = \frac{87.10}{32} = 0.61$

$P_k = 3 = \frac{69.34}{32} = 0.49$

$P_k = 4 = \frac{57.48}{32} = 0.46$

$P_k = 5 = \frac{38.94}{32} = 0.27$

TABLE 6 ARRANGEMENT OF AUTOCOVARIANCE AND AUTOCORELATION

K	0	1	2	3	4	5
Auto Covariance	142.13	108.32	87.10	67.34	57.48	38.94
Auto Correlation	1	0.76	0.61	0.49	0.40	0.27

ESTIMATING THE PARAMETER ϕ_1 & ϕ_2 FOR THE AUTOREGRESSIVE PROCESS

Recall

$P_1 = 0.76 \quad P_2 = 0.61$

$\phi_1 + \phi_2 P_1 = P_1$

$\phi_1 P_1 + \phi_2 = P_2$

Substituting the values of P above into the equation

$\phi_1 + 0.76\phi_2 = 0.76$ ------------ (1)

$0.76\phi_1 + \phi_2 = 0.61$ ------------ (2)

Multiply equ. (1) *by* 0.76

(2) *by* 1

$0.76\phi_1 + 0.58\,\phi_2 = 0.58$ ---------- (3)

$0.76\phi_1 + \phi_2 = 0.61$ ---------- (4)

Subtract (4) from (3)

$-0.58\,\phi_2 = -0.03$ ----------- (5)

From equ (5)

$\phi_2 = 0.05$

Substitute $\phi_2 = 0.05$ in equ (1)

$\phi_1 + 0.76\,(0.05) = 0.76$

$\phi_1 + 0.04 = 0.76$

$\phi_1 = 0.72$

$\therefore \quad \phi_1 = 0.72, \quad \phi_2 = 0.05$

OBTAINING THE ORDER OF THE AUTOREGRESSIVE MODEL FROM THE PARTIAL AUTOCORRELATION FUNCTION

RECALL

$P_1 = 0.76, \quad P_2 = 0.61$

$\phi_{11} = P_1$

$\phi_{11} = 0.76$

$\phi_{22} \quad = \frac{.61 - .76^2}{1 - .76^2} = 0.07$

$\therefore \quad \phi_{11} = 0.76, \quad \phi_{22} = \quad 0.07$

Hence

ϕ_{22} is not significant i.e.

$\phi_{22} = 0, k > 1$

Therefore, the autoregressive process is of order one i.e. AR (1) and the model is given as

$Y_t = \phi_1 y_{t+1} + \sigma + \sum_t$

Assuming $\sum_t$ and σ to be zero since the series is stationary as observed in the sample autocorrelation. Thus, the autoregressive model for this process can be presented as

$Y_{t+1} = \quad \phi_1 y_t$

Where

$Y_t \Rightarrow$ Last figure in the series

NOTE

$\phi_1 = 0.76, \quad y_t = 217.64$

FORECASTING THE AUTORESSIVE PROCESS AR (1) FOR 2004 QUARTERS FOR FIRST QUARTER

$Y_{t+1} = \quad \phi_1 \; y_t$

$= 0.76 \times 217.64$

$Y_{t+1} = \quad 165.41$

FOR SECOND QUARTER

$Y_{t+2} = \quad \Upsilon \phi_1 y_{t+1}$

$= \quad 0.76 \times 165.41 \quad = \quad 125.71$

$= \quad 125.71$

FOR THIRD QUARTER

$Y_{t+3} = \quad \phi_1 y_{t+2}$

$= \quad 0.76 \times 125.71 \quad = \quad 95.54$

FOR FOURTH QUARTER

$Y_{t+4} = \quad \Upsilon \phi_1 y_{t+3}$

$= 0.76 \times 95.61 = 72.66$

$= 92.66$

FORECASTED FIGURES FOR 2004 QUARTERS

QTR1	=	165.41
QTR2	=	125.71
QTR3	=	95.61
QTR4	=	72.66

X. FINDINGS

1 Fluctuations in sales are mostly apparent in '96 and '98. This might be due to lack of adequate supply of stock to the depot.

2 Sales at its peak between '01 and '03. This might
Be due to sharp increase of prices of petroleum produce. The series witness stationarity for the years under study. This was as the sample autocorrelation

3 The forecast for the series is best obtained at autoregressive model of order- one i.e. AR(1)
4The forecasted values for 2004 quarters were
Observed to be less than the observed values for the previous year. More also, as the forecast for 2004 Quarters were increasing in the same order, the forecasted values were decreasing. This simply explains the

standpoint of the exorbitant prices and the mind of the consumers. This is to say, there might be general fall in sales in future if the consumers have their way.

XI. RECOMMENDATION

1. Community and labour union disturbance which From time to time abrupt crude oil product and sales of refined products should be resolved by federal government in order to ensure a violent free environment for the company's operations.
2. The mode of operation in most of the section at the Depot is still very obsolete government should therefore, computerize the various section in the depot to enhance efficiency. More also, emphasis should be place on data management in order to ease assessment of the depot at any point in time.
3 The concept of mono-product economy should be de-emphasized. In other words federal government should from now attend to agriculture, and solid minerals, this would help to diversify employment base and foreign exchange earnings

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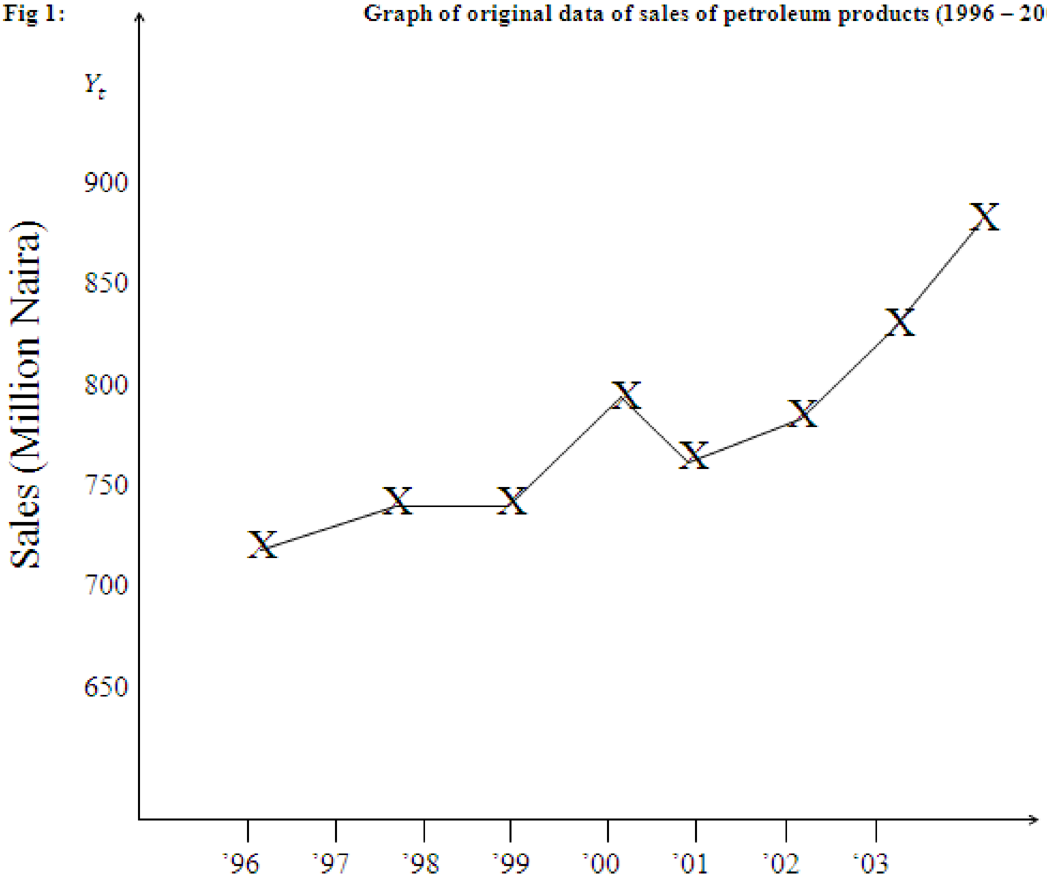
APPENDIX I

Fig 1: **Graph of original data of sales of petroleum products (1996 – 2003)**



APPENDIX II

Fig 2GRAPH OF THE SAMPLE AUTOCORRELATION FUNCTION (COROLELO GRAM)