A STATISTICAL INVESTIGATION OF FISH PRICES IN NIGERIA

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ABSTRACT

The main objective of this study is to describe and characterize the behaviour of fish prices in Nigeria over time. Drawing upon aspects of the data from a nationwide fish survey in 1980/81 and on various secondary data, the study analyses the pattern of fish price movement and makes projections of fish prices in Nigeria till 2002 A.D. It is concluded that unless efforts are directed at stemming inflation in fish prices, prices paid by fish consumers in Nigeria will be more than doubled within the next two decades.

INTRODUCTION

In Nigeria, protein intake is inadequate and the sources of protein are not expanding fast enough to meet the demand (Olayide, et al). The importance of fresh and frozen fish in the diet of Nigerians is increasing as the drought in the Sahellian region is decreasing cattle population - the traditional source of animal protein for Nigerians. In order to adequately provide fish in such quantities as to make it available at a reasonable price to Nigerians there is need for adequate information on prices.

While a time series data bank is being compiled, analysis of available data provides guidelines for fishing regulation policies. The present effort is directed at providing such information. Explicitly, the objective of this study is to examine available estimable functions which may be useful in describing or characterizing the behaviour of fish prices over time particularly in this initial period of data collection, in the absence of detailed information.

In a competitive economy, price is an important variable and it becomes vital in a consumer-oriented economy like Nigeria's. Several attempts have been made to control the inflationary prices in Nigeria and in order to make the control work the policy makers must obtain price information which, when analyzed, will form the basis or guidelines for the policies designed to stem the inflation.

The paper is divided into four sections. Section II discusses the methodology for the study. In Section III, results of an analysis of a nation-wide fish survey are presented. On the basis of the analysis, projections of fish prices made are contained, along with the conclusions of the study, in SectionIV.

METHODOLOGY

Statistical Investigation

The modern world is a world of numbers and measurements. Our everyday life events are expressed and bound up in numbers. What we eat, wear and say are expressed in numbers and measurements. Planned national targets of production, employment, unemployment, income etc. are expressed in numbers. These numbers, especially those relating to economic variables, must be compiled, analyzed and used in policy formulations. The science which is concerned with this aspect of our life is STATISTICS.

The lay conception of statistics includes the collection and presentation of large masses of data, sometimes it may include the calculation of totals, averages, percentages, etc. These are but incidental part of statistics which is the technology of the scientific method. Statistics provides tools for making decisions when conditions of uncertainty prevail. There are two broad areas of statistics - descriptive and inferential. The former is concerned with summarizing and describing data while the latter deals with the process of using data to make decisions about the general case of which these data are a part. Thus statistics is the tool that researchers employ in both their theoretical and empirical investigations.

In attempting to verify theoretical models, economists most often employ the classical least squares method (OLS), a statistical estimation procedure. In using this technique - the set of variables involved in a linear model is normalized so that one variable is dependent and the other or others independent. The assumption under which the classical least squares method operates are many and stringent. See for example Kmenta (4). While this method yields sample estimates with desirable statistical properties, it may not be appropriate for analyzing some economic problems. This inappropriateness is discussed by Dowling and Glahe (2). Of particular interest are the two categories of problems - appropriate specification and estimation of single equation models and the simultaneous nature of the economic system. The problem of statistical investigation in developing countries is compounded further by lack of reliable and adequate data. Ladipo (5) discussed the latter problem in some details.

Alternatives to OLS have been discussed and obtained by Haavelmo, Koopmans, Theil, Rubin and Leipnik as mentioned in (2), for example. All the methods developed require data which are not always available in developing countries. This leads to the need for using approaches that can use available data with some trade - off on rigorous ideal statistical estimation methods. An investigator or researcher in a developing country faces three main problems. In the first place, he has to consider whether or not the theoretical framework which is developed and set within the economic structure of an advanced industrial nation fits his own developing economy. Secondly, he must consider the inappropriateness of available techniques of estimation under certain conditions and ponder on the consequence of inaccurate estimates and the consequent misleading prescriptions. Finally, he must face the need to use scanty data for economic analysis.

Functions Characterising Price Behaviour Over Time

To estimate price movements, several functions lend themselves to use. The type of function to employ at any particular time depends on prevailing circumstances.

Of the funtions used to describe price movements in time series, some are characterised by an upper asymptote and a slope which tends to zero. For example, the semi-logarithmic function with y representing price and t time,

$$y = a + b \log_e^t, \quad b < 1 \ldots\ldots\ldots\ldots\ldots (1)$$

has slope $\frac{dy}{d_t} = e^a pt^{b-1}$

which tends to zero as t tends to infinity. Also, the reciprocal (or inverse) function

$$y = a - b/t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

has slope $\frac{dy}{dt} = b_2$

and an upper asymptote at y = a. There is also the logarithmic reciprocal function (log y = a - b/t) which has a point of inflexion and approaches an upper asymptote.

All these functions can have their parameters estimated using least squares regression methods, when data are available in appropriate quantity. Two other functions exist which also have asymptotic properties but which cannot be estimated by the ordinary least squares methods. These are the modified exponential funtion,

$$y = k + ab^t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$a < o$$

$$o < b < 1$$

with slope $\frac{dy}{dt} = ab^t \log_e b$

and the Gompertz curve

$$y = ka^{bt} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$o < a < 1$$

$$o < b < 1$$

with slope $\frac{dy}{dt} = (k \log_e{}^a \ \log_e{}^b) \ b^t \ a^{bt}$

For the modified exponential, the slope is monotonically decreasing and the function approaches an upper asymptote of k. For the Gompertz curve, which describes the so-called law of growth, it can be shown that at the initial stage, growth is slow, then becomes rapid, up to a point of inflexion, then starts to decline and the function approaches an upper asymptote of k (1)..

The choice of which of these functions to use is partly decided by theoretical considerations on the assumed behaviour of price over time, and partly by the quantity of data available for estimating the parameters. In view of this, trends described by asymptotic growth curves such as the modified exponential and the Gompertz curve, are of some interest to us.

The procedures for estimating the parameters k, a, and b in the modified exponential function have been described by Croxton and Çowden (1). The data are divided into three equal parts, and the totals of these subdivisions are taken. Let

$$Yi = \sum_{i=1}^{n} yi \ ; \quad Y_2 = \sum_{i=n+1}^{2n} yi; \quad Y_3 \ \sum_{i=2n+1}^{3n} yi$$

where n is the number of observations in each third of the data and price yi represents the ith price. It can be shown that

$$b^n = \frac{Y_3 - Y_2}{Y_2 - Y_1} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$a = (Y_2 - Y_1) \quad \frac{b-1}{n} \quad (b-1)^2 \ \ldots\ldots (6)$$

$$k = \frac{1}{n} \ (Y_1 - \frac{(b^n - 1)a)}{(b - 1)\ )} \ \ldots\ldots\ldots\ldots (7)$$

The Gompertz curve (4) can be transformed to

$$\log_e y = \log_e k + (\log_e a)b^x \quad \ldots\ldots\ldots\ldots\ldots (8)$$

which is similar in form to (3). Therefore the parameter estimating equations can be shown to be

$$b^n = \frac{Y_3^1 - Y_2^1}{Y_2^1 - Y_1^1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$\log_e a = (Y_2^1 - Y_1^1) \left(\frac{b - 1}{(b^n - 1)^2} \right) \quad \ldots\ldots\ldots\ldots\ldots (10)$$

$$\log_e k = \left(Y_1^1 - \frac{b^n - 1}{b - 1} \log_e a \right) \quad \ldots\ldots\ldots\ldots\ldots (11)$$

Where

$$Y_1^1 = \sum_{i=1}^{n} \log_e yi$$

$$Y_2^1 = \sum_{i=n+1}^{2n} \log_e yi$$

$$Y_3^1 = \sum_{i=2n+1}^{3n} \log_e yi$$

It is obvious that for the parameters of the two functions to be estimable there should be at least three observations. Reliability will improve as the number of observations gets larger.

EMPIRICAL RESULTS

Data Source and Quality

The data on fish prices that will be used here were obtained in a nation wide fish survey carried out in 1980-81. During fieldwork, major fish production and consumption areas were identified and surveyed. Data were also obtained from the operations of five major fish marketing firms, cover three fish species - Staverda, Skumbia and Mackerel.

There are four participants in fish distribution in Nigeria i.e. the company (or firm), the factor (or dealer), the agent and retailer. Therefore, four stages of distribution can be identified in the determination of fish prices - company to factor (firm-dealer), factor to agent (dealer-agent), agent to retailer and retailer to consumer stages. The price of each fish species was traced across these stages for each company for each town. In each case one price was obtained for each year.

The prices used are average prices; simple company averages for each species were taken over towns; species averages were obtained by weighing company averages by the number of selling points (towns) for each company covered in the survey; general averages were obtained by weighing species averages by the number of selling points in which a particular species was sold. These operations were performed for the years 1973 to 1981. Table 1 provides species average prices as well as general average prices for each stage of distribution for the years covered by the survey.

Table 1: Fish Price (K/Kg) By Distribution State, 1973-81

Year	MACKEREL				SKUMBIA				STARVEDA			
	C – F	F – A	A – R	R – C	C – F	F – A	A – R	R – C	C – F	F – A	A – R	R – C
1973	33.8	37.0	37.5	45.5	37.8	35.9	37.3	52.1	33.5	34.5	31.5	49.0
1974	42.0	45.0	47.0	57.0	42.0	34.5	34.2	60.0	n.a	57.0	n.a	n.a
1975	44.7	48.7	51.6	61.0	40.7	39.9	43.1	42.0	55.0	35.0	35.0	n.a
1976	43.0	45.3	48.2	54.3	44.0	47.3	48.3	53.2	33.0	51.7	89.0	n.a
1977	48.7	60.1	73.7	80.9	45.0	46.8	47.1	58.3	48.8	42.0	36.3	55.0
1978	39.3	44.4	49.3	58.4	33.8	43.4	48.0	58.0	48.0	39.3	49.0	74.6
1979	46.4	59.0	60.2	83.2	40.1	48.1	50.6	61.4	48.3	49.6	48.4	57.0
1980	44.1	48.4	49.8	63.5	45.0	49.9	50.9	60.1	51.6	55.6	50.5	63.7
1981	44.4	50.7	51.1	64.0	43.8	49.1	54.4	59.5	50.0	54.5	55.8	66.5
Average	42.9	48.7	52.0	63.1	41.4	43.9	46.0	56.1	46.0	46.6	49.4	60.3
Margin	–	5.8	3.3	9.1	–	2.5	2.1	10.1	–	0.6	2.8	10.9

Source: Survey Data

Note:

C – F Company/Factor Interphase

F – A Factor/Agent Interphase

A – R Agent/Retailer Interphase

R – C Retailer/Consumer Interphase

Two shortcomings of the data need to be mentioned. First, the use of 'point price' instead of many prices for one year neglects the fluctuations in price which may be seasonal in nature. If the 'point price' is not a good average for the many possible prices that could have been observed there is a possibility of some bias in the projected series. Our only excuse for using these 'point prices' is the inadequacy of resources for observing many prices and taking account of the fluctuations. The bias that could have been introduced may not be significant.

Secondly, the relatively short period of nine years covered by the survey will appear to impose a limitation on the usefulness of any projected series from the data.

Table 2 shows average fish prices by distribution stage for the period 1973 to 1981. In the table we have extracted the average fish prices for the various stages of distribution given in Table 1. Prices at different stages are seen to change from year to year and from one distribution stage to another.

At the firm/dealer interphase, average fish price during the period studied was 43.3 kobo per kilogram. On each kilogram of fish, the dealer (or factor) obtains a margin of 3.1 kobo for a markup of 7.2%.

In the distribution channel, the lowest mark-up (5.2%) goes to the agent who receives a margin of 2.4 kobo per kilogram. Functions carried out by the agent and other distributors in the Nigerian fish marketing system, have been described by Ladipo (6). The role of the retailer who receives a margin of 10.4 kobo/kg has also been emphasized. Average retail price of fish during the period covered, stood at 59.2 kobo/kg. It is the final market price that is subject to further analysis in this study.

Table 2: Average "Fish Price," 1973-81 (Kobo/Kilogram)

Year	Firm/Dealer	Dealer/Agent	Agent/Retailer	Retailer/Consumer
1973	35.0	35.8	35.4	47.5
1974	42.0	45.5	40.6	58.5
1975	46.8	41.2	43.2	51.5
1976	40.0	48.1	61.8	53.8
1977	47.5	49.6	52.4	64.7
1978	40.4	42.4	48.8	63.4
1979	44.9	52.2	53.1	67.2
1980	46.9	51.3	50.4	62.4
1981	46.1	51.4	53.8	63.3
Average	43.3	46.4	48.8	59.2
Margin	-	3.1	2.4	10.4

Estimation

The parameters of both the modified exponential function and the Gompertz curve are estimated below. We refer to the modified exponential function as first model and the Gompertz curve as second model.

In estimating the parameters we concentrate on the average fish prices at the various stages of distribution. However, we did not totally neglect the components of these averages, which are the prices of the various species.

In interpreting the results we like to bear in mind the restrictions on the parameters imposed by the desired property of asymptotic behaviour. In the case of the first model, a < o and o < b < 1. For the second model, o < a < 1, and o < b < 1. An examination of the estimating equations show that for an increasing series, if the restrictions on b are satisfied those on a will also be satisfied.

In Table 3 we provide estimates of the parameters of the first model, with 1973 as base year, for the various stages of fish distribution; using general average prices. It can be observed that all the restrictions are satisfied, indicating that the projections will converge towards the asymptote k. In the brackets are also provided the number of the component species prices whose projected series are also convergent (out of nine species prices. Thus while not all component prices converge, average prices converge for the model.

Table 3: Parameters Estimated Via Exponent Model.

Stages	b	a	k
C - F	2.4390	2.8492	63.9394
F - A	0.8409	- 110.6783	63.8900
A - R	- 0.1301	- 38.7584	63.8820
R - C	0.4508	- 44.4313	104.8700

Table 4 contains similar information for the second model. Here again all average price series converge.

Before we proceed to the other tables, it is necessary to point out some observed anormally in Tables 3 and 4. The system of fish price determination dictates that prices rise as the retail stage is approached. This is demonstrated in Table 2. However the asymptote indicated for the agent-retailer stage for Table 3 are lower than those indicated for the factor-agent stage, which is a lower stage of distribution. There is therefore the situation where agent-retailer prices are lower than factor-agent prices, indicating negative profits to the agents. In Table 4 also, the asymptote indicated the factor-agent stage is lower than that for the company-factor stages.

We have tried to look for the explanation for this anomaly in the equations estimating parameter b, since this parameter determines the other parameters. The estimated value of b for agent-retailer price in Table 4 is negative and that for factor-agent is 0.7181 which is less than the value for the company stage which is 2.1474. These differences become reflected in the estimated values for a and k.

Table 4: Parameters Estimated Via Gompertz Model.

Stages	b	$\log_e a$	$\log_e k$
C - F	2.1474	0.0203	0.5329
F - A	0.7181	1.9318	0.3041
A - R	- 0.0996	- 0.2159	0.4916
R - C	0.4264	- 0.1877	0.5364

A further investigation of equation(s) shows that the equation can be rewritten in the form

$$b^n = \frac{d_2}{d_1} c_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

where $d_i = \dfrac{Y_{i+1} - Y_i}{Y_i}$

and $c_i = \dfrac{Y_{i+1}}{Y_i}$

Now, $d_i = c_i - 1$

and $c_i = d_i + 1$

$$\text{Therefore } b^n = \frac{d_2}{d_1}(d_1 + 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

$$= d_2 + \frac{d_2}{d_1}$$

The value of b depends on the d's, particularly the ratio of d_2 to d_1. The higher this ratio the higher are the values of d_1 and d_2 which represent growth rates in prices.

In Table 5 we provide the growth rates derived from the average prices for the various stages of fish distribution using a different method. It is there shown that growth rate in price is lowest at the company-factor stage (0.65% annual growth rate). Fastest growth rate is recorded to be 5.08% annually at the agent-retailer stage while it is 3.49% at the retailer-consumer stage.

The latter growth rate is applied on current retail fish price and projections made up till 2002 A.D.

PROJECTIONS AND CONLUSIONS

In Table 6 we provide the projections, from 1973 to 2002, of the general average retailer-consumer fish price for two models. The first is based on data contained in Table 5 while the second derives from raw retailer-consumer data in Table 2.

Some comparisons can be made about the two models and projection bases shown in Table 6. First, for the two bases, the first model has higher values than the second. Secondly, the first model adopts a lower growth rate (3.49% annually) than the second model whose growth rate is 4.28% for fat fish price in Nigeria.

Table 5: Growth Rates of Average Prices (1973-81) by Distribution Stage

Year	C - F		F - A		A - R		R - C	
	T_1	d	T_2	d	T_3	d	T_4	d
1973	-	-	-	-	-	-	-	-
1974	41.27	-	40.83	-	39.73	-	52.50	-
1975	42.93	0.0040	44.93	0.1004	48.53	0.2215	54.60	0.0400
1976	44.77	0.0043	46.30	0.0305	52.47	0.0812	56.67	0.0379
1977	42.63	- 0.0478	46.70	0.0086	54.33	0.0354	60.63	0.0699
1978	44.27	0.0385	48.07	0.0293	51.43	- 0.0534	65.10	0.0737
1979	44.07	- 0.0029	48.63	0.0116	50.77	- 0.0128	64.33	- 0.0118
1980	45.97	0.0431	51.63	0.0617	52.43	0.327	64.30	- 0.0005
1981	-	-	-	-	-	-	-	-
Average		0.0065		0.0404		0.0508		0.0349

Note

T_1 - T_4 give values for 3-year moving averages at different distribution stages

$$d_i = \frac{Yi + 1 - Yi}{Y_i}$$

Table 6: Projected Retail Fish Prices, 1973-2002 (Kobo/Kilogram)

Year	1st Projection Model	2nd Projection Model
1981	66.54	63.30
1982	68.86	66.01
1983	71.26	68.84
1984	73.75	71.79
1985	76.32	74.86
1986	78.98	78.06
1987	81.74	81.40
1988	84.59	84.88
1989	87.54	88.51
1990	90.60	92.30
1991	93.76	96.25
1992	97.03	100.37
1993	100.42	104.67
1994	103.92	109.15
1995	107.55	113.82
1996	111.30	118.69
1997	115.18	123.77
1998	119.20	129.07
1999	123.36	134.59
2000	127.66	140.59
2001	132.12	146.36
2002	136.73	152.62

Generally, the projections indicate moderate price increases from year to year. If conditions remain the same, it is forecast that average consumer fish price may double in 21 years (based on the first model) and 17 years (using the second model), averaging out to be 19 years for a doubling in price.

This conclusion from our projections is conditional on there being no changes in the conditions prevailing in fish trade in Nigeria between 1981 and the turn of this century. It is also to be borne in mind that the price of a commodity greatly influences the quantity demanded of that commodity.

The quantity demanded of any commodity could be defined as

$$q_n^d = f\ (Pn,\ P_1\ \ldots Pn - 1,\ Y,\ T,\ A)$$

where q_n^d = quantity of commodity n (fish in this case) demanded at any point in time.

P_n = price of fish

$P_1 \ldots P_n - 1$ = price of related products such as substitute commodities (e.g. beef, mutton, goat meat etc.)

Y = Income
T = Taste preferences
A = Population and all other factors

It is a known fact from elementary economics that if the demand of any commodity increases faster than its supply, the price of that commodity will rise. The increasing price of feed for poultry has the effect of increasing poultry meat prices; the downward movement of the Sahara is sure to have an adverse effect on the supply of meat from goat, sheep and cattle and this will definitely increase the price of meat in the country. If these increases in the prices of the various substitutes for fish push the commodities beyond the reach of a large proportion of the population, the net effect will be an increase in the demand for fish. Secondly, as income (Y) increases, the demand for fish also increases. Furthermore, the competition for fish as an ingredient in livestock feed will increase its demand, compounded by increases in demand which will be generated by change in technology and better distribution of fish. One can therefore foresee a rapid increase in fish demand in the immdediate future with consequent rise in fish prices.

It could be concluded therefore that unless efforts are directed at stemming inflation in fish prices, the price of fish paid by the consumer will be more than doubled within the next two decades. Continuing efforts must be made at understanding price movements in order to arrive at policy alternatives directed at controlling inflation in fish prices in the country.

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