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SUPPLY AND DEMAND EQUATIONS FOR LIVESTOCK PRODUCTS IN NIGERIA: A SIMULTANEOUS EQUATION APPROACH

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Target Audience: Agricultural policy makers and economists,

ABSTRACT

In this study, an attempt was made to estimate Nigeria's demand and supply equations for livestock products using the simultaneous equation model. The parameters of the specified structural equations were computed from the reduced equations using the Inverse Least Square (ILS) approach. The results show that price is the major determinant of livestock products' supply and demand. Price elasticities of supply and demand were 0.5577 and 0.3309 respectively. Also, demand was national income elastic (1.2862). Projecting into future demand and supply shows that between 1999 and 2005, supply would be short of demand by an average of 17,466 tonnes. To therefore increase livestock products supply, governments at all levels must provide incentives for enhancing sustainable livestock production. This is expected to lead to increased demand if there is reduction in prices.

Keywords: Livestock products, supply, demand, simultaneous equation, structural equations, reduced equations.

DESCRIPTION OF PROBLEM

Considerable decreases in annual per caput protein supply have recently degenerated into serious nutritional deficiency in many Nigerian rural and urban households. Generally, inability of the rate of food production to cope with the rate of population growth has resulted into a widened food demand-supply gap. For instance, while Nigeria's population now grows at the rate of 2.83 per cent annually (11), staple food production only grew at the rate of 2.86 per cent between 1997 and 1998 as against the expected rate of about 4.0 to 5.0 per cent (12). Also, lack of effective demand for available food due to general low level of income and hike in prices has further worsened and compounded the dimension of the food crisis.

Consequently, malnutrition remains one of the most intractable problems facing sustainable economic development in Nigeria. Precisely, 13.5 million

people (about 17 per cent of the estimated population) were malnourished in 1980 (5). In 1992, it was indicated that the percentage had risen to 36 per cent (about 32. 7 million people) (6), while it latter rose to 40.7 per cent in 1996 (7). It can therefore be said that the goal of increased domestic food supply, which has been the central objective of Nigerian agricultural policies in the past four decades has met with abject frustrations. No doubt, the common nosh-up of the 1970s is now a mere nostalgia. Poor enough, Nigeria can no longer boast of being able to provide the minimum essential food nutrients for healthy growth of her population.

However, while the problem of calorie is little bearable, protein deficiency is acute and chronic in the nation (7). For instance, per caput protein supplied in Nigeria decreased from 60 gram in 1985 to 51 gram and 58 gram in 1986 and 1990 respectively (2, 1, 4, 5). It is also surprising that protein from animal sources only constituted 9.5 per cent of the total supplied in 1995 (63.31 gram), while crops supplied 90.5 per cent (7). Specifically, eggs, beef, milk, goat meat, mutton and bush meats supplied 1.23 gram, 0. 75 gram, 0.34 gram, 0.33 gram, 0.28 gram, and 0.28 gram respectively. Protein shortages have therefore resulted into diseases like kwashiorkor, night blindness, and slow development of many Nigerian children, among other severe and unbearable health hazards borne by the adults (14).

The Federal Government has therefore seen the need to increase per caput protein supply by encouraging livestock and fish production. In livestock, efforts have been made by successive Nigerian governments to increase domestic production through increased research efforts geared towards development of disease resistant breeds that are high yielding and resistant to the harsh tropical climate. The National Animal Production Research Institute (NAPRI) and the National Veterinary Research Institute (NVRI) have been established to assist in this respect, while other institutions of research are not left out.

Table 1: Average Livestock Production in Nigeria (1985-1999) ('000MT)

Livestock Type	1985-90[1]	1991-91[2]	1996-99[3]	%Change (1 to 2)	%Change (2 to 3)
Beef	253.80	185.50	202.25	-26.9	19.02
Goat meat	73.95	79.00	96.00	6.82	21.51
Mutton	79.00	80.50	101.75	1.64	26.39
Poultry	55.60	65.83	77.25	18.38	17.34
Pork	39.40	38.00	44.00	-3.55	15.78
Egg	286.00	384.83	436.00	34.55	13.29

Source: CBN Annual Report and Statement of Accounts (Several Issues

Notwithstanding, livestock production continues to fluctuate in Nigeria.

Table 1 shows that average beef production decreased from 253,800 tones in 1985-1990 to 185,500 tones in 1991-1995. Although average production increased in all livestock products between 1991-1995 and 1996-1999, the increases are not too significant. Going by the fact that meat is an excellent source of most B-complex vitamins most especially niacin, and that the protein it supplies is of high quality (8,9), increased domestic production of livestock is a sine qua non for addressing protein deficiency in Nigerian diets, given the current agitations over depletion of the fishery resources. This study therefore has the objective of analyzing the livestock products data on supply and demand in Nigeria. The other part of the paper discusses the method of analysis, results of analysis conclusion.

MATERIALS AND METHODS

The data used in this study were obtained from the Federal Office of Statistics (FOS) and the Central Bank of Nigeria (CBN) publications. Data on livestock supply and demand cover the period of 1988 to 1998. The data were aggregated over all the livestock products like beef, mutton, milk, egg, goat meat, poultry meat, pork, cheese, offal etc. The simultaneous equation approach was used to estimate the coefficients of the equations because, theoretically, while demand and supply are largely determined by price, price too could be largely determined by supply and demand (13, 15).

The structure of the model is specified as follows:

Demand: $D = a_0 + a_1P + a_2Y + U_1$ ..... (1)

Supply: $S = b_0 + b_1P + b_2W + U_2$ ..... (2)

Equilibrium $D = S$ ..... (3)

Where:

D = Quantity demanded ('000MT).

S = Quantity supplied ('000Mt).

P = Average price of meat products (N/Kg).

Y = National Income (Billion N)

W = Weather (represented by total rainfall in mm due to the fact that rainfall determines to a large extent the value of temperature and humidity which are other factors that could be considered)

At equilibrium, the reduced form equations are defined as:

$D = \pi 10 + \pi 11Y + \pi 12W + V1$ ..... (4)

$P = \pi 20 + \pi 21Y + \pi 22W + V2$ ..... (5)

Where πs are the parameters.

Because the structural equations 1 3 are exactly identified, the Indirect

Least Square (ILS) method was used to estimate the parameters of the reduced equations 4 and 5. Therefore, Ordinary Least Square (OLS) regression analysis was used to estimate the parameters of the reduced equations without imposition of any restriction. Latter, the estimated parameters were used to estimate those of the structural equations from the following derivations (13).

$$a_0 = \pi_{10} - \frac{\pi_{20}\pi_{11}}{\pi_{21}} \quad \ldots\ldots\ldots\ldots \quad (6)$$

$$a_1 = \pi_{11}/\pi_{21} \quad \ldots\ldots\ldots\ldots \quad (7)$$

$$a_2 = -\pi_{22}\{\pi_{11}/\pi_{21} - \pi_{12}/\pi_{22}\} \quad \ldots\ldots\ldots\ldots \quad (8)$$

$$b_0 = \pi_{10} - \frac{\pi_{20}\pi_{12}}{\pi_{22}} \quad \ldots\ldots\ldots\ldots \quad (9)$$

$$b_1 = \pi_{12}/\pi_{22} \quad \ldots\ldots\ldots\ldots \quad (10)$$

$$b_2 = \pi_{21}\{\pi_{11}/\pi_{21} - \pi_{12}/\pi_{22}\} \quad \ldots\ldots\ldots\ldots \quad (11)$$

Estimates of the elasticities of the independent variables (price, income and weather) in the structural equations were computed using the formula:

$$\text{Elasticity} = \frac{\text{Percentage change in the dependent variable}}{\text{Percentage change in the independent variable}}$$

This measures the degree of responsiveness of the dependent variable to changes in the values of the independent variables.

In order to project into future supply and demand for livestock products in Nigeria, the trend analysis was used to determine the values of each of the independent variables (price, income and weather) in the projected years, and then latter using it to compute the values of demand and supply. The equations estimated were:

$$P = C_0 + C_1T + e_1 \quad \ldots\ldots\ldots\ldots \quad (12)$$

$$Y = D_0 + D_1T + e_2 \quad \ldots\ldots\ldots\ldots \quad (13)$$

$$W = E_0 + E_1 + e_3 \quad \ldots\ldots\ldots\ldots \quad (14)$$

Note: e_i = Error Terms.
T = 1, 2, 3 ... 11 for 1988, 1989, 1990 ....1998 respectively.

RESULTS AND DISCUSSION

The reduced forms of the structural equations defined in equations 1, 2, and 3 were first estimated using the Ordinary Least Square method (OLS) regression. The results are presented in equations 15 and 16.

$$D = -855.654 - 0.021W + 33.051Y^* \quad \text{Adj. } R2 = 0.865 \quad \text{D. W.} = 0.815 \text{ ----- (15)}$$
$$(569.198) \quad (0.015) \quad (4.086)$$

P = -78.167** - 0.00045W + 1.179Y* Adj. R2 = 0.874 D.W. = 1.886 ------ (16)
(19.485) (0.001) (10.140

Note: * = Significant at 1 per cent level
** = Significant at 5 per cent level
Standard errors are in parentheses

Equation 15 shows that only national income (Y) is statistically significant ($p<0.01$). The adjusted R2 is 0.865, implying that the variables that were included only explained 86.5 percent of the variations in the values of the quantity of livestock products demanded. Similarly, in equation 16 with price as the dependent variable, only the national income variable (Y) is statistically significant at $p<0.01$ respectively. The adjusted R2 is 0.874, which implies that the independent variables included only explain 87.4 percent of the variation in the average price of livestock products.

The parameters of a_0, a_1, a_2, b_0, b_1, and b_2 in the structural equations 1 and 2 were estimated from equations 6 to 11 based on the results in equations 15 and 16. The final results are stated in equations 17 and 18.

$$D = 2792.139 + 46.667P - 22.006Y \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (17)$$

$$S = 1333.220 + 28.002P - .00839W \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

From equation 17, contrary to a prior expectation, the coefficient of price is with positive sign. This can be traced to low level of total supply at every point in time. Precisely, total livestock products supplied during the period studied was 17,950,040 tonnes, the total demand was 17,748,610 tonnes. This shows that the total quantities demanded were 98.87 per cent of total quantities supplied. The close demand-supply gap can be explained from the fact that unlike crops that are easily perishable, livestock could be kept till farmers get good price. Even when the animals are to be slaughtered, the number that would only be demanded could be determined from previous market demand.

The coefficient of price variable is 46.667 and it implies that one (1) unit change in price would lead to a 46.667 unit change in the total quantity demanded. The positive sign could be attributed to rising inflation in the nation since the mid-1980s. The price elasticity of demand is 0.5577. This shows that a 10 per cent change in the price of livestock would lead to a 5.577 per cent change in price. Thus, livestock products are demand inelastic with respect to price.

Furthermore, equation 17 shows that the parameter of national income has a coefficient of -22.006. This implies that 1 unit change in national income will lead to 22 units change in the total quantity of livestock products demanded. The negative sign could be attributed to rising prices of the

commodities, which may negatively affect total quantity demanded even if total expenditure increases. This tallies with some previous research findings (17), but contrary to some (16). In addition, the growing dimension of poverty in Nigeria may make people's attention to be shifted to cheaper sources of protein like those from plant sources. This is most likely in a situation when income is not evenly distributed. The elasticity of national income was computed as 1.2862. Demand for livestock product is therefore income elastic showing that 10 per cent change in national income would lead to 12.86 per cent change in demand.

From equation 18, the positive sign of the price parameter goes in line with a priori expectation. The parameter has a value of 28.002, which indicates that 1 unit change in the value of price will lead to 28 units change in the quantity of livestock products supplied. The supply elasticity of price is 0.3309, which shows that livestock products are also price inelastic. The coefficient also shows that a 10 per cent change in price would lead to 3.3 per cent change in supply. This is reasonable due to the fact that livestock cannot be manufactured overnight as done for other industrial goods. Farmers can only respond to price increases in the short term by improving on the management of available livestock. It is only in the medium term period that supply of milk from dairy cow can respond to price. What can possibly be done is to improve feeding and care given to the animals.

The weather variable (rainfall) has a coefficient of 0.00839. The negative sign shows that increase in rainfall would lead to reduction in supply. This appears reasonable due to the fact that increased rainfall may lead to increase in disease infections that would result into low productivity. Elasticity of supply with respect to weather is inelastic (-0.1252). This implies that a 10 per cent change in total rainfall would lead to 1.25 per cent change in total livestock supplied.

The projection into livestock products supply and demand for the years 1999 to 2005 was done from the estimated parameters of equations 12 to 14. The results are presented in the equations below:

$$P = \underset{(3.07)}{-5.062} + \underset{(.443)}{4.058T^{*}} \quad \text{Adj. } R^2 = 0.892, \text{ D.W} = 1.791 \quad \ldots\ldots\ldots \quad (19)$$

$$Y = \underset{(1.486)}{74.04^{*}} + \underset{(0.219)}{3.378T^{*}} \quad \text{Adj. } R^2 = 0.959, \text{ D.W.} = 0.478 \quad \ldots\ldots\ldots \quad (20)$$

$$W = \underset{(2156.449)}{29988.1^{*}} + \underset{(317.951)}{77.591T} \quad \text{Adj. } R^2 = -.104, \text{ D.W.} = 1.499 \quad \ldots\ldots\ldots \quad (21)$$

Note: * = Significant at 1 per cent level
Standard errors are in parentheses

Equations 19 to 21 were used to compute the projected values of price,

income and weather for the years projected. These values were later used to compute the projected demand and supply. The results are presented in Table 2. The results show that between 1999 and 2005, price of livestock products per kilogram would steadily increase from N43.633 to N 67.982. Also, national income would increase from N 114.576 billion in 1999 to N 134.844 in 2005. Total rainfall would also increase from 30919.192 mm in 1999 to 32380.00 mm in 2005.

Table 2: Projected Values of Livestock Products Supply and Demand in Nigeria (1999 - 2005)

Year	Price	Income	Rainfall	Supply	Demand	Supply - Demand Gap
1997[1]	34.82	106.70	32380.00	2016.71	2016.58	+0.13
1998[1]	37.21	109.30	33602.00	2124.70	2124.34	+0.36
1999	43.633	114.576	30919.192	2295.61	2308.001	-11.391
2000	47.692	117.954	30996.783	2408.62	2422.08	-13.465
2001	51.750	121.332	31074.374	2521.60	2537.124	-15.524
2002	55.808	124.71	31151.965	2634.59	2652.162	-17.572
2003	59.866	128.088	31229.556	2747.57	2767.20	-19.63
2004	63.924	131.466	31307.147	2860.55	2882.23	-21.68
2005	67.982	134.844	31384.738	2973.53	2996.39	-22.86

1 = Actual values of published data.

The projected demand would increase from 2,308,001 tonnes in 1999 to 2,996,390 in 2005, while supply would increase from 2,295,610 in 1999 to 2,973,532 in 2005. There are some gaps between demand and supply. Precisely, the highest gap of -22,860 tonnes was computed for 2005. It was observed that the supply-demand gap increases with time. Precisely, between 1999 and 2005 supply of livestock products would be short of demand by an average of 17,466 tonnes.

CONCLUSION AND APPLICATION

Sustainable livestock production is a necessary condition for bridging the expected livestock supply-demand gap in Nigeria in the first half decade of the new millennium. Governments at all levels must rise to this challenge by giving incentives to livestock farmers in form of timely supply of inputs at reasonable prices. Research development and utilization of better technological packages for enhancing the productivity of livestock in the tropical climate would also help. Breeds of livestock that are highly productive, resistant to environmental stresses of the tropical climate and acceptable to consumers should be developed to reduce incidence of livestock

death through disease infections that are rampart during the rainy season. The role of extension agents in the dissemination of appropriate technological packages also needs to be fully explored. All these, no doubt, will lead to increased resproduction, reduction in the cost of production, and reduction in the selling prices of the products for increased demand by low-income earners.

The government must also ensure that food prices are relatively stable for increased demand. This is necessary because increase in income that cannot compensate for increase in price is worthless. Although livestock products are found to be demand inelastic with respect to price, its being income elastic is an indication that increasing the purchasing power of people's income through policies that affect prices or directly affect the income level stands a great chance of improving animal protein demand in Nigeria. However, the aggregation nature of the data hinders formulation of specific policies for each type of livestock.

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