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Household Demand for Meat in Nigeria

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Abstract

This study was an application of the Linear Approximate Almost Ideal Demand System (LA-AIDS) model on household aggregate meat demand in Nigeria. The data used was obtained from the World Bank's Living Standards Measurement Study (LSMS) on households in Nigeria. Previous research had studied demand only at a regional level but this study estimates meat demand at a national level. The results showed that beef was a necessity while goat, chicken and mutton were luxuries. The results further revealed that all the meat products considered were normal goods with own-prices that were negative and consistent with demand theory except mutton. Goat meat and mutton were price elastic and as such, price changes for these products will affect their consumers more than consumers of other meat products that were less elastic.

Key words: Linear Approximate Almost Ideal Demand System (LA-AIDS), meat, demand, elasticity, own-price, cross-price.

1. Introduction

Several studies on household meat demand have been carried out around the world but relatively few studies have been carried out on household demand in Nigeria and none in recent times. This is not indicative of a general lack of interest on the part of scholars in the region. Partly responsible for this dearth in research would be inadequacies in available data in terms of breadth, depth and scope. Previous studies on household food demand in Nigeria have been at the state (regional) level. Examples include demand for cassava products in Lagos State (Jumah et al., 2008), food demand in Kogi and Kwara states (Obayelu et al., 2009), meat demand in Abia state (Igwe and Onyekwere, 2007), rural household food demand in Ondo state (Fashogbon and Oni, 2013), etc.

Food is necessary for human existence and meat plays a key role in that existence. Meat products are rich sources of nutrients that enable human growth and development. Enriched with high value biological protein and vitamins, meat facilitates the development of the gastrointestinal tract, cranio-dental features (teeth, jaw, etc.) and posture (Pereira and Vicente, 2013). Its consumption in adequate quantities ensures normal functioning of the immune system, mucous membranes and metabolic processes (Biesalski, 2005).

In Nigeria, meat, fish and animal products are the fourth most commonly consumed food group (88.9%) by households. Its consumption lags behind grains and flours (97.2%), oils and fats (96.8%) and vegetables (96.7%). Compared to other food groups, average weekly household expenditure was highest for meat, fish and animal products (₦1, 359 per week) (National Bureau of Statistics, 2016). A variety of meat products are purchased and consumed across the country. The acceptance and popularity of each meat product varies by region. For example, pork is not as widely accepted in the northern part of the country as it is in the south. This is mostly due to

religious reasons. The northern population are predominantly Muslims while the southern populace are predominantly Christians.

This study uses recent household survey data to examine the response of aggregate meat demand to variations in price and incomes. Household surveys provide the opportunity to test theories about household behavior and their response to changes in their economic environment (Deaton, 1997). We analyze meat demand using the linear approximate almost ideal demand system (LA-AIDS) model. Prior research on this subject have focused on particular regions and the use of recent country-level data distinguishes this study from others.

The study is organized as follows: section 2 reviews extant literature on food demand; section 3 explains the AIDS model; section 4 provides information on the data and the econometric model; section 5 interprets and discusses the results while section 6 concludes.

2. Literature Review

Investigating the demand for various meat products amongst rural and urban households in Kenya, Bett et al. (2012) surveyed 930 households across six counties and estimated demand elasticities using the LA-AIDS model. The authors were particularly interested in comparing the consumption pattern of the indigenous chicken against the exotic chicken, beef, mutton and “other meat” products. Their keen interest in the indigenous chicken was based on the belief that it is easily accessible and readily available in rural and urban areas relative to other meat products. Their results revealed that indigenous chicken, beef and mutton were necessities as shown by their expenditure elasticities. Furthermore, the indigenous chicken and beef were substitutes while the indigenous chicken, exotic chicken and goat meat were complements as shown by the signs of the cross-price elasticities. The socio-demographic factors suggested to

have a significant effect on meat consumption were household location, family size and proportion of household members.

Studying consumption and expenditure at a disaggregated product level provides an understanding of consumer demographic factors affecting expenditures on the product. Attempting to achieve this level of understanding, Nayga (1995) studied US household consumption and expenditures on fourteen meat products at a disaggregate level. Information on price and quantity were not available in their data and as such they could not impute price variables for their empirical model but assumed constancy of relative prices. Using a two-step censored regression technique, they observed various demographic factors affecting meat expenditures. Their results also revealed that variables such as household size (number of persons in the household), age, race (black, white or other race), education and region (Northeast, Midwest, South, and West) had a statistically significant effect on meat expenditures.

Examining consumer demand for cassava food products in Lagos, Nigeria, Jumah et al. (2008) analyzed the effect of household socio-demographic characteristics on the consumption of gari, lafun and fufu (all of which are cassava by-products). They attempted to capture consumer behavior that might lead to informed policy recommendations and hence potentially boost productivity, improve food security and reduce poverty through job creation. In order to accomplish their objective of estimating a separable demand system, they surveyed 300 households residing in Lagos State. Employing a LA-AIDS model, and assuming weak separability, they estimated a separable demand system for these food products. Their results provides evidence that characteristics such as religion and residential area (that is, whether or not the household resided in a low or high income area) explained the variations in the consumption of the three food products.

Estimating household meat demand at both the aggregate (beef, lamb, pork, chicken) and disaggregate levels (beef, lamb, fresh pork, ham, bacon, chicken) in Australia, Cashin (1991), employed the LA-AIDS model. As commonly observed in household studies where incomplete data often leads to exclusion of food items, fish and mutton were excluded from their analysis due to data unavailability and reliability. Although all the elasticities were of the appropriate sign, their results revealed large differences in numerical values of cross-price elasticities as well as a lot of negative values in the uncompensated cross-prices. This was suggested to be indicative of a strong income effect or data inadequacies. Regarding elasticities, at the aggregated product level, beef and lamb were price elastic (absolute value greater than one) while pork and chicken were inelastic and gross substitutes. At the disaggregated level, fresh pork and ham were price elastic while beef, lamb, bacon and chicken were inelastic. Furthermore, fresh pork and chicken were gross complements. Such that if demand increases for fresh pork, quantity of chicken demanded would increase as well.

Household surveys that contain information on expenditures and quantities of food items purchased but lacking price information have resulted in a number of approaches to compensate for the lack of price data in the estimation of a demand system. (Castellón et al., 2015) used budget shares and Consumer Price Index (CPI) to construct Stone-Lewbel (SL) price indices that could be used to estimate a demand system where prices were absent. They further evaluated the likelihood of the Consumer Price Index (CPI) influencing estimated marginal effects and elasticities. They found that the observed variations in the Stone-Lewbel prices were as a result of household heterogeneity and not the CPIs.

3. Conceptual Framework

The model used here is the linear approximate almost ideal demand system (LA-AIDS) which is more frequently used due to its ease of estimation than the almost ideal demand system (AIDS). The AIDS model is a flexible system of demand equations developed by (Deaton and Muellbauer, 1980). These demand equations exhibit a linear relationship between the budget shares of commodities, real total expenditure and relative prices. The AIDS model itself belongs to the PIGLOG family (Price-Independent Generalized Logarithmic preferences) and thus possess important desirable properties required in conventional demand analysis. However, difficulty in estimating the AIDS model due to the non-linear price index gave rise to the LA-AIDS model (see e.g. Blanciforti and Green 1983 and Alston et al., 1994).

The AIDS demand functions in terms of budget share is given by

$$(1) \quad w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln (x/P) + \varepsilon_i \quad i = 1, \dots, n$$

where w_i is the budget share of good i , p_j is the price of good j , x is the total expenditure, ε_i 's are random disturbances and P is a price index defined by

$$(2) \quad \ln P = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_j \sum_k \gamma_{kj} \ln p_k \ln p_j \quad k = 1, \dots, n$$

where p_k is the price of good k and γ_{kj} are the parameters to be estimated.

Replacing the price index in (2) with Stone's price index ((P^*)) gives rise to the linear approximate almost ideal demand system (LA-AIDS) which is simpler and more frequently used than the non-linear AIDS as we mentioned earlier. Stone's Price Index is given by

$$(3) \quad \ln P^* = \sum_{w_k} \ln p_k$$

The following restrictions are imposed on the parameters of the AIDS model:

- (4) $\sum_{i=1}^n \alpha_i = 1 \quad \sum_{i=1}^n \gamma_{ij} = 0 \quad \sum_{i=1}^n \beta_i = 0$ Adding-up
- (5) $\sum_j \gamma_{ij} = 0$ Homogeneity
- (6) $\gamma_{ij} = \gamma_{ji}$ Symmetry

Provided equations (4), (5) and (6) hold, the AIDS model given in equation (1) represents a system of demand functions that add up to total expenditure ($\sum w_i = 1$), are homogenous of degree zero in prices and total expenditure, and satisfy Slutsky's symmetry.

Studies on household demand assume a multistage budgeting process within the household and weak separability. That is, a household first allocates its income across broad food and non-food categories then further allocates its income amongst items in each category. We assume that the meat group is weakly separable from other food and commodity groups. This assumption allows us to limit the number of prices appearing in each equation to the four products in the meat group (see e.g. Cashin, 1991)

4. Empirical Analysis

Data

The data used in this study is cross-sectional data obtained from the Nigerian General Household Survey (GHS) which was implemented between 2015 -2016. The data collection process was a team effort between the Nigerian National Bureau of Statistics (NBS), the Federal Ministry of Agriculture and Rural Development and the World Bank's Living Standards Measurement Study (LSMS). The survey captures information on household characteristics including age, marital status, religion, education, illnesses, disability, child anthropometrics, consumption, food security and shocks and several other aspects of household living.

Respondents were drawn from each of the thirty-seven states in Nigeria. There were ten households in each enumeration area (EA or primary sampling unit) and each state had sixty enumeration areas. The total number of enumeration areas for all thirty-seven states in the country was twenty two thousand, two hundred (22, 200).

Regarding food unit measures, respondents were allowed to report purchase and consumption in units that they were most familiar with. We estimated kilogram-equivalent measures for responses on meat products reported in non-standard units using the national conversion factor for these non-standard measurements. However, conversion factors for meat products was unavailable. Rather than dropping these observations, we adopted the conversion factors for fresh fish since those were available and were the closest proxies we could use for meat. In some instances, households had reported conflicting measures for purchase and consumption. For example, if a household reported the quantity of beef purchased in terms of *heap small* and reported the quantity consumed in kilograms, we converted *heap small* to kilograms.

Commonly observed in micro-data such as household surveys is the issue of missing values. According to Nayga (1995) and Deaton (1997), the proportion of the sample with zero consumption or expenditure makes household-level data sometimes problematic. Constrained by the need to have sufficient information on both quantity and expenditures that could be estimated, we selected four meat products (beef, goat, chicken and mutton) for demand estimation. These products had more observations than other meat products - some of which had less than five observations. We excluded pork, bush meat (wild game meat), duck and canned beef. Households that reported no information on quantity purchased and expenditure for all four

meat products were dropped. We retained those that had information on at least one of the four meat products.

Price information was not included in the survey. We estimated unit values for each meat product by dividing the expenditures on that product by its purchased quantity. We regressed these unit values on variables region and sector (rural or urban) in order to impute the prices. The imputed prices account for household price variability according to region and sector. Since information on the time (day, week or month) the survey was conducted was unavailable, we could not account for price variations according to day, week or month.

The sample size for this study was 4, 580 households. Controlling for households with no information on purchase, consumption and expenditure reduced our sample size to 2, 412. Dropping households that failed to report expenditure information may cause self-selection bias. To assess this, we compared the means of the variables used in the analyses with and without the dropped observations and it was not significantly different (see Nayga, 1995). The variables used in this study include region, sector, prices and quantities purchased of beef, chicken, goat meat, mutton and their total expenditures.

Econometric Model

The econometric model used is the LA-AIDS model with Stone's price index given by

$$(7) \quad w_i = \alpha_i^* + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{x}{P^*} \right) + \varepsilon_i^*$$

where $\alpha_i^* = \alpha_i - \beta_i \alpha_i$ and $\ln P^* = \sum_{w_k} \ln p_k$. Imposing homogeneity in equation (5) by substitution, we estimated equation (8) rather than equation (7)

$$(8) \quad \bar{w}_i = \alpha_i^* + \sum_j^{n-1} \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{\bar{x}}{P^*} \right)$$

where \bar{w}_i indicates the sample mean of the budget share of good i , \bar{x} is the sample mean of the log of real total expenditures. According to Green and Alston (1990), the expenditure, uncompensated and compensated elasticities for the LA-AIDS model are given by

Expenditure Elasticity:

$$(9) \quad e_i = 1 + \frac{\beta_i}{w_i}$$

Uncompensated (Marshallian) price elasticity:

$$(10) \quad \eta_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i \alpha_j}{w_i} - \frac{\beta_i}{w_i} \sum_k \gamma_{kj} \ln P_k$$

where δ_{ij} is the Kronecker delta that is unity if $i=j$ and zero otherwise

Substituting for η_{ij} in the Slutsky equation we get the compensated elasticities (η_{ij}^*). The

Slutsky equation is given by

$$(11) \quad \eta_{ij}^* = \eta_{ij} + w_j \left(1 + \frac{\beta_i}{w_i}\right)$$

Hence, the compensated elasticity is given by,

$$(12) \quad \eta_{ij}^* = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i \alpha_j}{w_i} - \frac{\beta_i}{w_i} \sum_k \gamma_{kj} \ln P_k + w_j \left(1 + \frac{\beta_i}{w_i}\right)$$

Parameter estimates and elasticities were estimated using the iterated seemingly unrelated regression (SUR) procedure in SAS.

5. Results and Discussion

Table 1 presents the descriptive statistics of the variables used in this study. Regarding the quantity purchased of each meat product, beef was the highest (1935kg) followed by goat

(554kg) then chicken (404kg) and mutton (361). In terms of price, beef was the most expensive (₦1253.89/kg) followed by chicken (₦980.81/kg) and mutton was the least expensive (₦712.02/kg).

Table 2 presents the parameter estimates of the LA-AIDS model. The estimates were estimated with restrictions of homogeneity and symmetry imposed. These restrictions were not satisfied. Ten of the fourteen parameter estimates were statistically significant. The own-price coefficient of beef (0.0867) in the beef equation means that a percent increase in the price of beef would increase the household's budget share for beef by approximately ₦0.09 (Nine kobo). The own-price coefficient of goat meat (-0.2560) in the goat equation indicates that a percent increase in the price of goat meat would decrease the household's budget share for goat meat by approximately ₦0.26 (Twenty-six kobo).

Table 3 presents the uncompensated (Marshallian) own and cross-price elasticities. Three of the four own-price elasticities had the expected negative sign and is consistent with demand theory. Mutton has a positive own-price elasticity. This suggests that an increase in its price increases its demand. This result was consistent with a similar study on meat demand in Nigeria. Adetunji and Rauf (2012) reported a positive own-price elasticity for mutton in their study on household demand for meat in Southwest Nigeria. It had a positive sign and it was greater than one. Mutton is a good source of lean meat but not as regularly consumed like beef, goat and chicken. In addition to that, Muslims in Nigeria use it to celebrate the festival Id-el-Kabir. During this festive period, price for mutton increases. As such, the price increase is seasonal.

The own-price elasticity for goat and mutton were greater than one in absolute value indicating price elastic demands while beef and chicken were price inelastic. Variations in the price of goat or mutton would affect its consumers more than consumers of beef and chicken.

Three of the four expenditure elasticities were greater in absolute value than their corresponding own-price elasticities. The positive expenditure elasticities for all the meat types indicate they were normal goods, these elasticities were also significant at the 1% level. The expenditure elasticity also reveals that with the exception of beef which is a necessity ($\eta_i = -0.8191$), all the other meat types were luxuries¹ ($\eta_i > 1$). Among the luxury meats, chicken had the highest expenditure elasticity ($\eta_i = 2.0266$). While beef and goat meat were gross substitutes, beef and chicken were gross complements.

Table 4 presents the compensated own and cross-price elasticities. Again, with the exception of mutton, own-price elasticities for beef, goat and chicken were negative, consistent with the inverse relationship between price and demand. All pairs of goods were substitutes except beef and chicken, beef and mutton and chicken and mutton.

Summary and Conclusions

In this study, the linear approximate almost ideal demand system (LA-AIDS) has been used to estimate aggregate demand for meat products in Nigeria using household survey data from the World Bank's Living Standards Measurement Study. Three of the four own-price elasticities were negative and consistent with demand theory. Mutton had a positive own-price effect which is consistent with similar studies. The results suggest that all the meat products considered were normal goods as revealed in their positive expenditure elasticities. Our results indicate that beef is a necessity and also suggest that goat and mutton are price sensitive. Hence, policies that cause variations in the prices of goat and mutton would potentially cause welfare distortions.

¹ Blanciforti and Green (1983) explain that negative β_i 's indicate necessities while positive β_i 's indicate luxuries. A negative β_i implies that $\eta_i < 1$ while a positive β_i implies that $\eta_i > 1$.

Some of the limitations of this research were due to the proportion of missing observations in the data. Future research should consider incorporating socio-demographic variables as well as model expenditures on meat products at a disaggregated level. This will enable all stakeholders in the meat industry capture the various factors affecting household expenditures.

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Table 1: Descriptive Statistics of Variables used in the LA-AIDS Model

Variable	Unit	N	Mean	Std Dev	Minimum	Maximum
Beef Quantity	kg	1935	1.16	1.07	0.00	15.30
Goat Quantity	kg	554	1.16	0.95	0.02	15.00
Chicken Quantity	kg	404	1.55	0.93	0.20	10.00
Mutton Quantity	kg	361	1.02	0.71	0.20	6.00
Beef Price	(₦ /kg)	2412	1253.89	586.63	464.14	2530.00
Goat Price	(₦ /kg)	2412	860.08	93.31	758.44	1000.00
Chicken Price	(₦ /kg)	2412	980.81	107.41	834.00	1133.14
Mutton Price)	(₦ /kg)	2412	712.02	116.69	525.20	896.09
Expenditure	(₦ /kg)	2412	1730.00	1826.54	2.53	21945.12

1\$USD = ~~₦~~ 312.81

The regions are comprised of the following states: North Central – Plateau, Kogi, Benue, Nasarawa, Niger, Kwara and FCT Abuja; North East – Adamawa, Taraba, Bauchi, Borno, Gombe and Yobe; North West – Kano, Jigawa, Kaduna, Zamfara, Katsina, Kebbi and Sokoto; South East – Abia, Anambra, Ebonyi, Enugu and Imo; South South – Akwa Ibom, Cross River, Bayelsa, Delta, Edo and Rivers; South West – Lagos, Ekiti, Osun, Ogun, Ondo and Oyo.

Table 2: Parameter Estimates of the LA-AIDS Model

Meat Products	α_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	β_i
Beef (w1)	0.6776* (0.0102)	0.0867* (0.0184)	0.0281 (0.0148)	-0.0155 (0.0104)	-0.0993* (0.0101)	-0.1272* (0.0104)
Goat (w2)	0.1243* (0.0096)		-0.2560 (0.0297)	0.1491* (0.0235)	0.0788* (0.0189)	0.0174** (0.0079)
Chicken (w3)	0.0570* (0.0106)			-0.01129 (0.0342)	-0.1223* (0.0232)	0.0889* (0.006)
Mutton (w4)	0.1411* (0.0086)				0.1427* (0.0219)	0.0209* (0.0058)

Note: One asterisk (*) indicates significance at the 1% level and two asterisks (**) indicates significance at the 5% level. Values in parentheses are the standard errors.

Table 3: Uncompensated Expenditure and Price Elasticities in the LA-AIDS Model

Meat Products	ε_{iB}	ε_{iG}	ε_{iC}	ε_{iM}	η_i
Beef	-0.5864* (0.0442)	0.0427 (0.0230)	-0.1205* (0.0194)	-0.1550* (0.0161)	0.8191* (0.0147)
Goat	0.0012 (0.1418)	-2.8499* (0.2144)	1.1445* (0.1721)	0.5786* (0.1369)	1.1256* (0.0568)
Chicken	-1.8272* (0.1928)	1.7055* (0.2764)	-0.5717 (0.3997)	-1.3333* (0.2708)	2.0266* (0.0653)
Mutton	-1.8547* (0.1944)	1.0967* (0.2649)	-1.5497* (0.3270)	1.0161* (0.3058)	1.2916* (0.0804)

Note: One asterisk (*) indicates significance at the 1% level. Values in parentheses are the standard errors. Elasticities are calculated from equations (9), and (10) for expenditure (η_i) and uncompensated (Marshallian) own - (ε_{ii}) and cross-price (ε_{ij}) elasticities respectively.

Table 4: Compensated Expenditure and Price Elasticities in the LA-AIDS Model

Meat Products	ε_{iB}	ε_{iG}	ε_{iC}	ε_{iM}	η_i
Beef	-0.0103 (0.0363)	0.1562* (0.0236)	-0.0495** (0.0201)	-0.0963* (0.0164)	0.8191* (0.0147)
Goat	0.7928* (0.1196)	-2.6940* (0.2147)	1.2420* (0.1729)	0.6592* (0.1370)	1.1256* (0.0568)
Chicken	-0.4020** (0.1635)	1.9863* (0.2765)	-0.3961 (0.4007)	-1.1882* (0.2709)	2.0266* (0.0653)
Mutton	-0.9464* (0.1612)	1.2756* (0.2651)	-1.4378* (0.3278)	1.1085* (0.3061)	1.2916* (0.0804)

Note: One asterisk (*) indicates significance at the 1% level and two asterisks (**) indicates significance at the 5% level. Values in parentheses are the standard errors. Elasticities are calculated from equations (9), and (11) for expenditure (η_i) and compensated own - (ε_{ii}) and cross-price (ε_{ij}) elasticities respectively.