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DETERMINANTS OF TABLE EGG DEMAND IN MUBI NORTH LOCAL GOVERNMENT AREA, ADAMAWA STATE, NIGERIA

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ABSTRACT

The study modelled table egg data to uncover the factors influencing table egg demand in Mubi North Local Government Area of Adamawa State, Nigeria. The research entailed a household survey based on multistage sampling that elicited data from 260 households. Diagnostic checks such as Smirnov-Kolmogorov test was used to test for normality, link test for model specification, Cook-Weisberg test for heteroscedasticity, Durbin-Watson test for autocorrelation and variance inflating factor for multicollinearity. Result of diagnostic checks following ordinary least square (OLS) technique revealed heteroscedastic, auto-correlated and non-normally distributed data set for the study, hence, necessitated the robust regression to correct for those anomalies. The factors influencing demand of table egg were predicted with coefficients in tandem with *a priori* expectations. Price of egg and age of household heads showed negative coefficient, while, price of substitute (fish), income, education, household size, and knowledge on nutrition status of egg showed positive coefficient. The results further disclosed a high R^2 of 72.17 and low Root Mean Square Error (RMSE) of 8.2145 revealed that the model was correctly specified. The study validated theoretical postulation of inverse proportionality between price and demand of commodity; applicable also in model for table egg demand in the study.

Keywords: Auto correlated, Egg, Demand, Heteroscedastic, Robust.

INTRODUCTION

In Nigeria, all the three scales of production (small, medium and large scale) contributes significantly to the national economy; larger chunk of the large scale producers operates in the southern part of the country, but recently, there is an upsurge in the northern Nigeria as well. The industry contributes in the provision of the dietary requirements for Nigerians, serves as a window of employment in the industry and its other related agro allied industry (poultry input-supply industry and poultry output-demand industry). Sahel Newsletter (2015) asserted as at 2013, the Nigerian poultry industry worth ₦80 billion (USD600 million) and composed of 165 million birds with a production index of 650,000 MT eggs and 290,000 MT poultry meat. The industry has suffered decline in productivity intermittently in the past basically due to diseases such as Avian Influenza (AI). In the last few years, the industry has been undergoing radical rate of growth; largely propelled by demand driven owing to population and ban on imports of poultry products (except day old chicks) into the Nigerian borders in 2003, thus, another compelling stimulant to the increase in domestic poultry production. In view of the demand driven scenario of the industry owing to population and the need to stimulate further domestic production, a study aimed to uncover the demand conditions and factors influencing the demand of poultry (table egg in specific), is imperative, thus, the focus of this research.

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MATERIALS AND METHODS

The Study Area

The research was conducted in Mubi North Local Government Area (LGAs) of Adamawa state. The area lies on latitude 10º 32' N to 10º 11' N and longitude 13°12' E to 13° 35'E; it is situated on the West bank of the River Yedseram; a stream flowing into the Lake Chad and is situated on the Western axis of the Mandara Mountain. It has an inter-state boundary with Borno State to the North, intra-state boundary with Hong Local Government Area to the West, Maiha Local Government to the South and an international boundary with the Republic of Cameroun to the East (Adebayo, 2004). It has 506.4Km^2 in land mass (Adebayo and Tukur, 1999) with estimated 151,072 human population (NPS, 2006). There are four (4) major districts (Mubi-Town, Bahuli, Mayo-Bani and Muchalla) in the area, which are further segmented into 11 political wards for administrative convenience. They are as follows: Mijilu, Lokuwa, Mayo-Bani, Kolere, Digil, Yelwa, Vimtim, Muchalla, Bahulli, Sabon-layi and Betso. Major ethnic identities include Fali, Gude, Marghi and Fulani. The inhabitants are predominantly farmers who produce several crops maize, beans, sorghum, and soy bean. Mubi is a commercial town hosting numerous commercial activities and its proximity to the Republic of Cameroun made international trade very visible; especially in livestock marketing.

Method of Data Collection

A primary source via Computer Assist Personal Interview (CAPI) embedded with structured questionnaire on android operating system device was used to collect data for the research.

Sampling Techniques

This research adopted multi-stage sampling technique in its data collection. In the first stage, a purposive sampling technique was used to select Mubi district as the study area out of the four (4) districts in the LGA. The purposive selection of Mubi district was premised on the basis of availability of egg consumers in relation to other districts which are mostly rural. In the second stage, four (4) most populated and cosmopolitan wards in Mubi district were selected, namely: Lokuwa, Kolere, Sabon Layi and Yelwa wards. The selection of these wards was premised on heterogeneity of wards in terms diversity of egg consumers. In the Final stage, a random sampling (non-proportionate) was adopted and 100, 50, 50 and 50 household table egg consumers in Lokuwa, Kolere, Sabon Layi and Yelwa wards respectively were selected. A total 250 household table egg consumers were served with structured questionnaire for the research.

Analytical Techniques

The study modeled a robust regression in examining the determinants of table egg demand in the area. Although the robust regression is not a very popular model (Hampel *et al*., 2005) and most of the software packages do not incorporate it (Stromberg, 2004). However, the choice of the robust regression was premised on its ability to overcome and correct for violations associated with the Ordinary Least Square estimator, additionally; it is insensitive to extreme observations, model misspecification and can address heteroscedasticity (Fox and Weisberg, 2013).

The theoretical demand model is presented as:

$$Q_d = b_0 + b_i X_i + u_i \quad \dots (1)$$

where;

b_i= coefficient of included variables,

X_i= vectors of variable,

b_0 = Slope,

Q_d = Quantity demanded and

u_i = error term

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Given the equ. 1, the demand model for table egg is specified as follows:

$$Q_d = b_0 + b_1P + b_2P_0 + b_3Y + b_4E + b_5S + b_6K + b_7A + u_i\text{n} \quad \ldots(2)$$

where;

Q_d = quantity of egg demanded
b_0 = constant term
P = current price per unit
P_0 =price of other substitute
Y = household income (per month)
E = educational level (number of years spend in school)
S = household size
K = knowledge about nutritive value of egg
A = age of household members in years
b_1 –b_9 =regression coefficient
U_i = error term

Diagnostic Check Tools

The Durbin-Watson-d-statistics propounded by Durbin and Watson (1950) was used to test the presence of autocorrelation in the table egg data. Baum (2006) stated that the Durbin-Watson-d-statistics is one of the oldest tests for autocorrelation, but still relevant and widely used and reported in econometric studies. The test is formulated as below:

$$d = \frac{\sum_{t=2}^{t=n}(\hat{\mu}_t - \mu_{t-1})^2}{\sum_{t=1}^{t=n}\hat{\mu}_t^2}; \simeq 2(1-\rho);\ 0 \le d \le 4 \quad \ldots (3)$$

where;

d = Computed Durbin-Watson-d value

The rule of thumb for this statistics is that the computed d value is compared with the tabular d_L and d_U. If $d < d_L$ = Positive autocorrelation exist, if $d > d_U$ or $d < 4 - d_U$ = No autocorrelation and if $d > 4 - d_L$ = Negative autocorrelation exist.

The variance inflating factor (VIF) test is used to detect collinearity among independent variables in regression models (Murray *et al.,* 2012). The VIF demonstrates how the variance of an estimator is inflated in the presence of multicollinearity (Gujarati and Porter, 2009). The VIF for multiple regression model with p predictors; X_i; $i = 1, \ldots \rho$, are the diagonal elements (r^{ii}) of the correlation matrix R_{pxp} of the predictors (Chatterjee and Price, 1977; and Belsley *et al.,* 1980). Thus, the VIF for a given predictor variable is expressed as:

$$\text{Variance Inflating Factor } (VIF_i) = r^{ii} = \frac{1}{1-R_i^2}; i = 1, \ldots \rho \quad \ldots (4)$$

where;

R_i^2 = Multiple correlation coefficient of the regression between X_i and other predictors. If VIF of a variable > 10; usually occurs when $R^2 > 0.90$ indicates that the variable is highly collinear; thus, the larger the VIF value the more troublesome.

Cook Weisberg Test

The Cook Weisberg test was used to test for heteroscedasticity in the table egg data. Yafee (2012) expressed the Cook Weisberg test as:

$$Var\ (e_i) = \delta^2 exp(Z_t) \quad \ldots (5)$$

where;

e_i = error in regression model, $Z = X\hat{\beta}$ = variable list supplied by user
The test is whether t = 0; hettest estimates the model as:

$$e_i^2 = \alpha + Z_it + V_i \quad \ldots (6)$$

it forms a source test

$$S = \frac{SS\ of\ the\ model}{2} \quad \ldots (7)$$

$$h_o: S_{df=p} \sim X^2 \quad \ldots (8)$$

where;
p = number of parameter.

RESULTS AND DISCUSSION

Ordinary Least Squares (OLS) Regression Result for Table Egg Demand

Table 1 presented OLS regression for the table egg demand in the research area; it shows four (4) of the seven (7) regressors as significant, but the signs of most the coefficients were not in tandem with the *a priori* expected outcome; furthermore, the result revealed a very low R^2 of 17.27%. The implication for the low R^2 value on the regression result indicated that the explanatory is very low hence the model is not fit for consideration (Gujarati and Porter, 2009). From the foregoing result, diagnostic check on the table egg data on table 2 to 6 revealed a non-normal, collinear, heteroscedastic and auto-correlated data. Hence, the OLS regression result in table 1 was adjudged as non-robust and spurious. This scenario necessitated the estimation of robust regression (Table 7) to correct for the anomalies inherent in the table egg data; which by default is robust/ reliable and adequate model for the table egg data. Table 1 results, in line with Yafee (2012), the chi-square probability (0.0000) was less than 0.05; a rejection of the null hypothesis and further implied a non-normally distributed residuals.

Table 1: Ordinary Least Squares (OLS) Regression Result for Table Egg Demand

Variable	Coefficient	Standard Error	t-value	95%	Confidence Interval
Constant	-2.5533	4.2142	-0.61	-10.8546	5.7480
P	0.3041***	0.0696	4.37	0.1670	0.4411
P_o	0.0001	0.0001	1.05	-0.0001	0.0004
Y	-1.99×10^{-6}	2.58×10^{-6}	-0.77	-1.07×10^{-6}	3.10×10^{-6}
E	3.3002***	0.8313	3.97	1.6626	4.9378
S	0.5144***	0.1656	3.11	0.1881	0.8406
K	-8.0440***	2.8855	-2.79	-13.7279	-2.3602
A	-0.0509	0.0506	-1.01	-0.1506	0.0487
N = 250					
F (7, 242) = 7.21					
P > F = 0.0000					
R^2 = 17.27					

Note: P = current price per unit, P_0 = price of other substitute, Y = household income (per month), S = household size, K = knowledge about nutritive value of egg, A = age of household members in years, E = educational level (number of years spend in school) and N = number of observations.

Predicted Residuals for Testing Normality and other Diagnostic Checks

The study also conducted diagnostic checks to evaluate how good the model was. Determining goodness of a model is further determined by how well the Y is predicted, the linearity of the model and the behavior of the residuals. On average, the distribution of the residuals (low magnitude) indicated that the predicted or fitted values did not deviate much from the observed values. The predicted residuals show the dispersion between the fitted and the observed values in a regression result and paly key role in diagnostic checking (Gujarati and Porter, 2009). Table 2 show summary of predicted residuals; three residual types:

normalized residual, standardized and studentized; each with its minimum, maximum, mean and standard deviation.

Table 2: Summary of Predicted Residuals for Testing Normality and other Diagnostic Checks

Variable (residual type)	Observation	Min.	Max.	Mean	Standard Deviation
Normalized Residual	250	-15.583	47.987	$1.07\text{x}10^{-8}$	8.098
Standardized Residual	250	-1.974	5.864	$3.52\text{x}10^{-3}$	1.002
Studentized Residual	250	-1.986	6.319	$1.42\text{x}10^{-5}$	1.022

Smirnov-Kolmogorov Result for Testing Normality of the Data

Table 3 presented the result of the Smirnov-Kolmogorov test for normality. It is a chi-square test to determine whether or not statistical significant difference exists between the cumulative distribution of the residuals and that of the theoretical normal distribution.

Table 3: Smirnov-Kolmogorov Result for Testing Normality of the Data

Variable	Observation	Prob. (Skewness)	Prob. (Kurtosis)	AdjChi^2(2)	Prob. >Chi^2
Residual	250	0.0000	0.0000	0.0000	0.0000

Link Test for Model Specification for Table Egg Demand

Table 4 showed the result of the link test to check for omitted variable bias in the model. The null hypothesis of no variable omission failed to be rejected since the p-value was not significant. Hence, the model had no omitted variable bias or did not need additional variable. Thus, the regression coefficient was consistent. In other words, the link test was used to check for model specification. Hence, we accept the null hypothesis that, there was no specification error. But since the p-value of _hatsq (0.977) was not significant, indicated failure to reject the null hypothesis and concluded that the egg demand model was correctly specified. The presence of model misspecification in regression could lead to omitted variable bias and when important variable is omitted the model becomes biased (Frost, 2019). The implication of this test was that it helped to verify that the variables included in the model were adequate and sufficient enough in addressing model for table egg demand.

Table 4: Link Test for Model Specification for Table Egg Demand

Quantity demanded (Qd.)	Coefficient	Std. Error	T-value	P-value	95% Interval	Confidence
_Cons	-0.0770	3.1966	-0.02	0.981	-6.3732	6.2191
_hat	1.0159	0.5734	1.77	0.078	-0.4342	2.1452
_hatsq	-0.0007	0.0253	-0.03	0.977	-0.0506	0.0491

Number of observations = 250
F (2, 247) = 25.77
P > F = 0.0000
R2 = 72.17
Root MSE= 8.1309

Variance Inflation Factor for Multi collinearity Test for Table Egg Demand

The variance inflation factor (VIF) was another diagnostic check used to detect the presence of multi collinearity in the data set; test result in Table 5. Result showed both individual variable and mean value of the variance inflating factor (VIF) as less that 10; an indication of absence of multi collinearity in the data set. The VIF is a measure of the rate of increase in variances and co-variances; thus, presence of multi collinearity increases variances and co-variances and conversely (Oscar, 2007). Consequences of multi collinearity among others high sensitivity of estimated coefficient to small changes in the model, which reduces its precision and making the p-values invalid (Frost, 2019). In the research, the foregoing consequences were circumvented since the data lacks multi collinearity and thus, the findings are stable (less sensitive to changes in the model) and can yield valid p-values.

Table 5: Variance Inflation Factor for Multi Collinearity Test for Table Egg Demand

Variable	Variance Inflating Factor (VIF)
E	2.15
N	1.81
S	1.17
P	1.14
A	1.04
Y	1.04
P_0	1.01
Mean of Variance Inflation Factor (VIF)	1.34

Note: P = current price per unit, P_0 = price of other substitute, Y = household income (per month), S = household size, K = knowledge about nutritive value of egg, A = age of household members in years and E = educational level (number of years spend in school).

Cook-Weisberg Tests for Heteroscedasticity in Table Egg Demand

Table 6 showed the result of Cook Weisberg test for detecting heteroscedasticity of the residuals. In line with Stock and Watson (2003) heteroscedasticity should always be assumed in a model. Thus, the null hypothesis that the residuals were heteroscedastic was assumed. The probability (0.0000) was significant, which implied the violations of homoscedastic assumption (Baum, 2006); thus, the residuals were heteroscedastic. In accordance with Yafee (2012), an insignificant result means lack of heteroscedasticity otherwise known as homoscedasticity; a condition that indicates the presence of equal variance of the residuals alone the predicted line. But, result in Table 6 is significant; thus, the data is heteroscedastic. Ullah (2012) stated that, in the presence of heteroscedasticity, the OLS estimator ceases to be BLUE (Best Linear Unbiased Estimator) leading to inefficiency of both the estimator and the estimates and tests of hypotheses (F-tests and t-tests) becomes invalid. However, our robust regression captures heteroscedastic-robust standard errors are meant to control for the effect of heteroscedasticity.

Table 6: Results of Cook-Weisberg Tests for Heteroscedasticity in Table Egg Demand

Test Type	Chi^2	$P > Chi^2$
Cook-Weisberg Test for Heteroscedasticity	317.70	0.0000

Durbin-Watson D-statistics for Testing First Order Autocorrelation

Table 7 showed the result of Durbin-Watson test for first order autocorrelation. From the table the computed d-statistics was 1.217. The Durbin-Watson tabular values at (n, k 5%)

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revealed d_L = 1.686 and d_U = 1.852. This is in line with Gujarati and Porter (2009) who computed-d < tabular-d; therefore, indicated the existence of positive autocorrelation in the table egg data.

Table 7: Result of Durbin-Watson d-statistics for Testing First Order Autocorrelation

Observation	K	Computed d-statistics (value)
250	8	1.217

Robust Regression Result for Table Egg Demand

Table 8 showed price coefficient (-0.3288). This indicated a negative relationship between price (P) of table egg and its household demand. The negative coefficient implied an increase in unit price of table egg decreased household table egg demand by 0.3288 units. For every ₦10 increase in the price of a table egg, its household demand decreased by 3 egg units. A t-value (5.26) indicated that the relationship was statistically significant at 1%. This relationship was in tandem with the conventional price-demand relationship. F-statistics (13.04) with p-value < 0.01 showed that the R^2 value was significantly different from zero. Thus, on the whole, statistical relationship exist between the regressors and demand for table egg. The implication for this the high R^2 value indicated a high explanatory power of the independent variables on the dependent variables and the significance of F-test indicated the overall reliability of the model.

Table 8: Robust Regression Result for Table Egg Demand

Variable	Coefficient	Standard Error	t-value	95%	Confidence Interval
Constant	-1.7941	3.7794	-0.47	-9.2390	5.6508
P	-0.3288***	0.0625	-5.26	-0.4520	0.2057
P_o	$9.02x10^{-5}$	0.0001	0.78	-0.0002	0.0003
Y	0.4779***	0.1474	3.24	0.1876	0.7682
E	0.2728***	0.0746	3.66	0.1258	0.4199
S	0.4902***	0.1487	3.30	0.1974	0.7831
K	0.8659***	0.2588	3.35	0.3562	1.3756
A	-0.0540	0.0454	-1.19	-0.1435	0.0355
N	250				
F (7, 242)	13.04				
P > F	0.0000				
R^2	72.17				
Root MSE	8.2145				

Note: P = current price per unit, P_0 = price of other substitute, Y = household income (per month), S = household size, K = knowledge about nutritive value of egg, A = age of household members in years, E = educational level (number of years spend in school) and N = number of observations.

Put in another way, it indicated the reliability of the regressors in predicting the table egg demand in the study area. The R^2 value (72.17); indicated 72% of total variation in table egg demand was explained by price of table egg, price substitutes, income of head of household, education level of head of household, household size, knowledge of household about nutritional status of egg and age of head of household. The root mean squared error (Root MSE) = 8.2 indicated a small standard deviation of the overall regression; the closer it is to zero, the better the fit. Yafee (2012) showed that regression output with lower RMSE values yield smaller standard deviation and thus, gives better fit than regression output with larger RMSE values.

Oscar (2007) showed that robust regression helps to control for data anomalies in regression such as heteroscedasticity to make the result more robust.

CONCLUSION AND RECOMMENDATIONS

The study modeled OLS estimator for the table egg demand and diagnostic checks revealed a non-normal, heteroscedastic and auto-correlated data set; thus, adjudged non-robust. In attempt to correct for the foregoing problems inherent in the data, a robust modelling estimator was used. The robust model predicted most of the predictors in the table egg demand significantly and with correct signs in tandem with *a priori* expectations. Thus, price of egg (-), income of household heads (+), education level of household heads (+), household size (+) and knowledge of household about the nutritional status of egg (+) significantly affects demand for table egg. Therefore, the study was a theoretical validation of the inverse relationship between demand and price of commodity. The study recommended that the stakeholders and policy makers in the poultry egg industry may find worthy indicators for rationale decision making in the industry for a prosperous micro economy.

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