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Double-Hurdle Model of Fresh Fish Consumption among Urban Households in South-West Nigeria

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Abstract: Most studies on consumption of products with possibility of observing zero-consumption for some consumers have modeled consumption function using the Tobit model, assuming that factors that are responsible for whether to consume a product or not are equally responsible for determining how much to consume. This approach has been severally faulted. This study investigated factors affecting consumption of fresh fish using the single step estimation method of the Tobit model, the independent double-hurdle approach and the dependent double-hurdle model. Data collected from 218 households in Abeokuta, South-west Nigeria were used for the study. Model fitness criteria revealed the superiority of joint estimation (dependent double-hurdle model). The model results revealed that husband's income, wife's income, expenditure on beef and dependency ratio significantly affected participation (decision to consume) while household size, husband's education, husband's income, wife's income, expenditure on dry fish and dependency ratio significantly affected consumption (how much to consume). It is recommended that public enlightenment should focus on the importance of consuming fresh fish among households and fresh fish sellers should focus on educated and high income households as this segment of the market demand more of the product.

Keywords: Demand, elasticity, income, joint analysis, Nigeria, single-step

INTRODUCTION

Fish is generally believed to be a comparatively cheaper and readily available source of animal protein in most countries around the world especially among the poor people in developing countries such as Nigeria. Fish and fish products are known worldwide as a very important diet because of their high nutritive quality and significance in improving human health.

Fish is also one of the most important animal protein foods available in the tropics (Eyo, 2001). In many Asian countries, over 50% of the animal protein intake comes from fish. Although, Olatunde (1989) reported that fish constitutes 40% of animal protein intake in Nigeria; the African proportion is 17.5% (Willman *et al*., 1998). Fish consumption has impact on human being throughout various stages of human life, including pregnancy and childhood.

Gomna and Rana (2007) reported an annual fish consumption of 5.8 and 9 kg/caput/year of meat in Lagos state south-west Nigeria. Despite the fact that fish is the cheapest and almost the most consumed source of animal protein in Nigeria, the level of consumption is still far below the world average (FAOSTAT, 2005). In addition, substantial proportion of the fish consumed in Nigeria is still being imported. Hence, the need to expand local production to meet increasing demand and safe the country from avoidable negative balance of payment.

Fish can be obtained from artisanal fishing which involves gathering fishes from the wild or from fish husbandry in different types of ponds. After harvesting, fish can be processed/handled through different methods before they are consumed. Fresh fish has been widely acknowledged as the one which minimizes nutrient loss and spoilage thereby giving maximum benefit for human health, body development and value for money.

Meanwhile, the issue of spoilage and loss of nutrient during processing, preservation, transportation and marketing reduces the amount of nutrients available to man and value for money. These problems make consumption of fish in fresh form the most viable option which reduces loss of benefits derivable from fish consumption. With the growing importance of fresh fish, empirical findings on households' responses to fresh fish demand become increasingly important for producers, marketers and policy makers alike. Most studies on consumption of products with possibility of observing zero-consumption for some consumers such as fresh fish have modeled consumption function using the Tobit model, assuming that factors that are

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responsible for whether to consume a product or not are equally responsible for determining how much to consume. This approach reduces consumption to a one-step process. Consumption has been shown to be a two-step process i.e., decision of whether or not to consume and how much to consume are determined by different socioeconomic variables (Lin and Schmidt, 1983; Haines *et al*., 1988; Lin and Milon, 1993; Moon *et al*., 2002; Huang *et al*., 1999; He *at al*., 2009; Wan and Wu, 2012).

Despite the demonstrated possibility that the Tobit model may be a misrepresentation of households' underlying consumption behavior, studies that have employed the Tobit model to analyze fresh items' consumption (Huang *et al*., 1981; Capps and Love, 1983; Smallwood and Blaylock, 1984; Blaylock and Smallwood, 1986) have failed to consider alternative specifications.

Yen and Huang (1996) in assessing the generalized double-hurdle model's appropriateness for demand analysis noted that zero-valued observations in household survey data may be generated from different sources such as abstention, misreporting and infrequency of purchases. Unfortunately, survey data generally do not contain detailed enough information to identify the different sources of zero observations. It has been argued that, when carefully interpreted, the probability of consumption in the double-hurdle model also reflects the probability of purchase and therefore, the double-hurdle model is also appropriate in modeling demand relationship with zeros resulting from infrequency of purchases. This study therefore is aimed at modeling fresh fish consumption as a two-step process (using a double-hurdle model) thereby providing more dependable baseline information as relates to fresh fish consumption in Nigeria using urban households in Ogun state South-West Nigeria as a case study. The study sought to determine factors affecting participation (first hurdle); determine factors affecting consumption (second hurdle) and compare the double hurdle estimates with the estimates of a single step process of the Tobit model.

Modeling consumption as a two-step process is expected to promote better understanding of the details of fresh fish consumption among households. Findings from this study will go a long way in providing necessary information for government agencies and bodies concerned with fish production, consumption, public health and nutrition in formulating policies aimed at improving fresh fish consumption in the country. Furthermore, Information on the impact or relative impact of various socioeconomic factors on the consumption of fresh fish can benefit both producers and consumers and may facilitate the decision making of policy makers. For example, such information can enable producers and marketers to focus on certain sub-sector of the population most likely to respond favorably. In addition, the information can be used to forecast or to project consumer expenditures as the explanatory variables change over time, thus enabling the industry to adjust in an appropriate manner.

Empirical framework: In consumption studies, there is always a probability of recording zero expenditure or consumption for certain goods. Ordinarily, the Tobit model developed by Tobin in 1958 is always adopted to accommodate the zero consumption figures alongside other positive values. The Tobit model is very restrictive in its parameterization because the factors that affect the level of consumption are assumed as the same as those that determine the probability of consumption. Furthermore, empirical results obtained with the Tobit model often are not robust across distributional assumptions (Arabmazar and Schmidt, 1981, 1982). Such limitations make the Tobit model unpalatable for such empirical analysis.

According to Reynolds (1990), the Tobit model is just one among several censored regression models that can be used to model consumption behavior. The specification of an appropriate model depends on the phenomenon that is assumed to give rise to the zeros. The tobit model assumes that zero expenditures are observed when desired consumption is non positive; thus the dependent variable is truncated at zero. A second explanation for the occurrence of zero expenditures is provided by Cragg (1971) who recognized that although the household may desire a positive amount of the good, impediments to acquisition (such as availability of the good and transaction cost) may effectively prohibit purchases. In conformity to this explanation, Cragg proposed a more flexible parameterization to the Tobit model, which he termed the "double hurdle" model. This allows separate stochastic processes for the participation and consumption decisions. It should be noted that the Tobit model is a single equation model allowing both zero and positive continuous values for the dependent variable. On the other hand, the Cragg's model assumes two independent processes i.e., decision to consume which is a dichotomous response (zero and one) and the extent of consumption which takes on positive values. Cragg (1971) posited that different factors may influence each of the two processes contrary to the assumption of the Tobit model. A third explanation is embodied in the "purchase infrequency" model. The model is based on the proposition that, in the case of infrequently purchased goods, zero expenditure may

have been recorded because the household purchased a stock of the good outside of the survey period.

Double-hurdle model of consumption: As the model's name suggests, two hurdles must be crossed in order to consume a commodity (fresh fish in this case). The "first hurdle" needs to be crossed in order to be a potential consumer of fresh fish. Given that the household is a potential consumer, their current circumstances then dictate whether or not the households do in fact consume and how much they consume- this is the second hurdle.

The double hurdle model contains two equations. This is written as:

$$d_i^* = Z_i'\alpha + u_i \quad (1)$$

$$y^* = X_i'\beta + v_i \quad (2)$$

$$\begin{pmatrix}\varepsilon\\ \mu\end{pmatrix} \sim N\left[\begin{pmatrix}0\\0\end{pmatrix},\begin{pmatrix}1 & 0\\ 0 & \sigma^2\end{pmatrix}\right]$$

Note from the diagonality of the covariance matrix that the two error terms are assumed to be independently distributed.
The first hurdle is then represented by:

$$di = 1 \text{ if } d^*>0 \quad (3)$$

$$di = 0 \text{ if } d^*\leq 0$$

The second hurdle closely resembles the Tobit model:

$$y^* = \max(y_i^{**}, 0) \quad (4)$$

Finally, the observed variable, y_i, is determined by the interaction of both hurdles as follows:

$$y = d_i y_i^* \quad (5)$$

The decisions of whether to participate in the market and about the size of Y can be jointly modeled, if they are made simultaneously by the individual; independently, if they are made separately; or sequentially, if one decision is made first and affects the other one (this is the dominance model). If the independence model applies (which was the initial position of Gragg (1971), the error terms are distributed as follows:

$$u_i \sim N(0, 1)$$

$$v_i \sim N(0, \sigma^2)$$

If both decisions are made jointly (the Dependent Double Hurdle) the error term can be assumed to have a bi-variate normal distribution defined as:

$$(ui, vi) \sim BVN\,(0, \psi)$$

where,

$$\psi = \begin{bmatrix}1 & \rho\sigma\\ \rho\sigma & \sigma^2\end{bmatrix} \quad (6)$$

According to Shittu (2008), on the assumption that $u_i \sim BVN\,(0, 1)$ and $u_2 \sim N(0, \sigma^2)$, it can be shown that:

$$\Psi = \begin{bmatrix}\sigma_1^2 & \sigma_{12}\\ \sigma_{12} & \sigma_2^2\end{bmatrix} = \begin{bmatrix}\sigma_1^2 & \frac{\sigma_{21}}{\sigma_1\sigma_2}\sigma_1\sigma_2\\ \frac{\sigma_{21}}{\sigma_1\sigma_2}\sigma_1\sigma_2 & \sigma_2^2\end{bmatrix} = \begin{bmatrix}1 & \rho\sigma\\ \rho\sigma & \sigma^2\end{bmatrix} \quad (7)$$

The model is a dependent model if there is a relationship between the decision to consume fresh fish and the amount consumed by households (Y) i.e.:

$$\rho = \frac{Cov(u_i v_i)}{\sqrt{\operatorname{var}(u_i v_i)\operatorname{var} v_i}} \quad (8)$$

If ρ = 0 and there is dominance (the zeros are only associated to non-participation, not standard corner solutions) then the model decomposes into a Probit for participation and standard OLS for Y (consumption). When ρ = 0, the double-hurdle model reduces to Cragg's Independent Double-Hurdle model. According to Zhang *et al*. (2006), when ρ = 0, x = z and α = β/σ, it leads the Tobit model.

The log-likelihood function for the double hurdle model is:

$$LogL = \sum_0 In\left[1 - \Phi(Z_i'\alpha)\Phi\left(\frac{x_i'\beta}{\sigma}\right)\right] + \sum_+ In\left[\Phi(Z_i'\alpha)\frac{1}{\sigma}\phi\left(\frac{y_i - x_i'\beta}{\sigma}\right)\right] \quad (9)$$

According to He *et al.* (2009), the two-stage decision nature implies that participation and consumption should be modeled jointly, partly to gain estimation efficiency. The double-hurdle model introduced in 1971 by Cragg has been frequently used to model two-stage decision processes. An advantage of the double-hurdle model compared with the standard univariate Tobit model is that it provides a more flexible framework to model the observed consumer's behavior as a joint choice of two decisions instead of a

single decision. As a result, it allows for the investigation of whether participation and consumption have the same set of determinants. Previous studies have reported that participation and consumption may be determined by different sets of factors (Moon *et al*., 2002; Huang *et al*., 1999; Lin and Milon, 1993). For fresh fish, a typical example is that allergy to fresh fish or availability may affect the participation decision but not consumption.

METHODOLOGY

Study area: The study area is Abeokuta, the capital city of Ogun State South-west Nigeria. The state was created in 1976 by the then Federal Military Government from the old Western region. It is located within latitudes 3°30'N-4°30'N and longitudes 6°30'E-7°30'E. The state has a total of 20 Local Government Areas. Abeokuta (the study area) has the highest population and it is the most urbanized city in the state. It is mostly populated by civil servants, artisans, traders, transport workers, student's etc. The number of artificial ponds in the city is on the increase due to the fact that more people gets involved in fish farming. There are various spots in the city where consumer can purchase fresh fish either reared in man-made ponds or gathered from the wild.

The state is bounded in the West by the Republic of Benin, in the south by Lagos state and the Atlantic Ocean, in the east by Ondo state and in the North by Oyo state. The state covers a land area of 16,762 km^2 with a population of 3,728,098 (2006 population census).

Sampling technique: Households were randomly selected across different locations in the study area. They were chosen carefully in order to cut across various socioeconomic groups. The city was delineated into high income areas (such as the Government Reserved Areas of Ibara, Oke-ILewo, Elega, Kemta and Oke-Ata), middle income area (such as Quarry Road, Olorunsogo, Idi-Aba and Kolobo) and low income areas (such as Ijaiye, Ago-Oko, Ilugun, Ikereku and Shaje). The households were selected using a systematic random sampling from the house street numbers which were used as sampling frame. In this method, sampling intervals were determined by dividing the frame by the required number of households in the street and households were selected at the calculated intervals. A total of 240 households were sampled for the study but 218 of the questionnaires were used for the analyses as twenty-two were discarded due to incomplete information.

METHOD OF DATA COLLECTION AND SOURCES

Primary data were used in this study. These were collected by personal interview and recording with the aid of structured questionnaires. Data were collected on socio-economic characteristics of respondents, households' consumption of fresh fish and reasons for consuming or for not consuming fresh fish, frequency of consumption, types of fresh fish consumed etc.

Analytical techniques:

Descriptive statistics: Frequency tables and percentages were used to describe the socio-economic characteristics of respondents.

Tobit model (single step estimation): Tobit regression analysis was carried out using the maximum likelihood estimation technique. Generally the Tobit model (also called censored regression) is defined as:

$$Yi = \beta_1 X_i + ui \text{ if RHS}>0$$

$$Yi = 0 \text{ if otherwise}$$

where,

$$X_i = X_1, X_2, \ldots\ldots X_n$$

here, the variables are defined as:

Y_i = Amount Spent on fresh fish by i^{th} household in the last one month in Naira
X_{1i} = Age of household head in years
X_{2i} = Age of wife in years
X_{3i} = Husband's Income in Naira per month
X_{4i} = Wife's Income in Naira per month
X_{5i} = Household size
X_{6i} = Educational level of husband in number of years spent in school
X_{7i} = Educational level of wife in number of years spent in school
X_{8i} = Amount spent on dry, frozen and smoked fish in Naira per month
X_{9i} = Amount spent on beef in Naira per month
X_{10i} = Dependency ratio estimated as the number of people that are not gainfully employed / total household size

It should be noted that variables X_8 and X_9 were included in the model because they represent expenditure on substitute goods.

The double-hurdle model: As stated earlier, the double hurdle model contains two equations written as:

$$d_i^* = Z_i'\alpha + u_i$$

$$y^* = X_i'\beta + v_i$$

In order to allow for ease of comparison Zis = Xis and Xis are as defined for the Tobit model above. This is to allow for comparison of the single step process involving the Tobit model with the two-step process involving the double-hurdle models and to compare the significance of the variables in the first and the second hurdle of the double-hurdle models:

$$\begin{pmatrix}\varepsilon\\ \mu\end{pmatrix} \sim N\left[\begin{pmatrix}0\\0\end{pmatrix},\begin{pmatrix}1 & 0\\ 0 & \sigma^2\end{pmatrix}\right]$$

RESULTS AND DISCUSSION

Socioeconomic characteristics of households: A cumulative of 78.9% of the household heads in the study was less than 50 years of age while 41.3% were specifically between the ages 31 and 40 years. The mean age of household heads was 43 years while the standard deviation was 11.8. Eighty-seven percent of the wives were still below the age of 50 years. Mean age of wives was 38 years while the standard deviation was 10 (Table 1)

Majority of the households (43%) sampled had between 3 to 4 people in their households with a mean of 4 people (Table 1). Mean income of household heads was ₦61, 087 while that of the wives was ₦32, 628 and the average household income was ₦92, 064 (Table 2). Majority of the household heads and wives had one form of formal education or the other (Table 3). Household heads and wives were distributed across various job types while only 7.3% of the wives are unemployed i.e., fulltime housewives (Table 3).

Fresh fish consumption issues and expenditure pattern on fresh fish, frozen fish and beef: Fifty-seven percent of the sampled households consume fresh fish at the household level while 41 and 22% consume claries (cat fish) and tilapia respectively. The implication of this is that there may be readily available market for catfish in the study area. This has a serious policy implication as some of the numerous unemployed youths in the city could be encouraged to engage in catfish farming. Among household members, wives were the major decision makers in fresh fish consumption. Therefore, producers/marketers of fresh fish can focus on housewives to stimulate demand for their products. While most households consume fresh fish for its nutritive values, others consume fresh fish as a panacea for their restriction on the consumption of beef due to certain health problems. Majority of those who do not consume fresh fish (23.9%) were of the opinion that fresh fish were too expensive. Others (20.2%) gave allergy as the main reason for not consuming fresh fish (Table 4). Households spent

Table 1: Age and size of the households

Variables	Frequency	Percentage	Cumulative %
Age of head			
≤30 years	32	14.7	14.7
31-40	91	41.3	56.0
41-50	49	22.9	78.9
51-60	28	12.8	91.7
61-70	16	7.30	99.1
>70	2	0.90	100
Mean	43 years		
Standard deviation	11.8		
Age of wives			
≤30 years	65	29.8	30.3
31-40	79	36.2	67.3
41-50	42	19.3	86.9
51-60	26	11.9	99.1
61-70	2	0.90	100
Mean	38		
Standard deviation	10		
Household size			
1-2	32	14.7	14.7
3-4	94	43.1	57.8
5-6	77	35.3	92.7
7-8	15	6.90	100
Mean	4		
Standard deviation	1.54		

Field survey data

Table 2: Monthly income distribution among households

Variables	Frequency	Percentage	Cumulative %
Income of head			
≤20,000	42	19.3	19.3
2,0001-40,000	56	25.7	45.0
40,001-60,000	55	25.2	69.7
60,001-80,000	33	15.1	85.3
80,001-100,000	10	4.60	89.9
>100,000	22	10.1	100.0
Mean	61,087,16		
Standard deviation	19,225		
Income of wife			
≤20,000	88	40.4	40.4
2,0001-40,000	70	32.1	72.5
40,001-60,000	38	17.4	89.9
60,001-80,000	12	5.50	95.4
80,001-100,000	2	0.90	96.3
>100,000	8	3.70	100.0
Mean	32,628.44		
Standard deviation	17,054		
Total household income			
≤20,000	6	2.80	2.80
2,0001-40,000	40	18.3	21.1
40,001-60,000	27	11.9	33.0
60,001-80,000	49	22.9	56.0
80,001-100,000	38	17.4	73.4
>100,000	58	26.6	100.0
Mean	92,064		
Std deviation	39,147		

Field survey data; US$ 1= ₦150 as at the time of data collection

Table 3: Educational levels and job of husbands and wife's

	Husbands		Wives	
Educ. level	Frequency	Percentage	Frequency	Percentage
No formal education	8	3.70	6	2.80
Primary school	22	10.1	18	8.30
Senior school	35	16.1	42	19.3
Technical school	10	4.60	-	-
NCE/OND	12	5.50	51	22.9
HND	26	11.9	13	6.40
BSc	80	36.7	72	33.0
MSc	8	3.70	9	3.70
PhD	3	1.40	1	0.50
Job types				
Civil service	98	45.0	100	45.9
Self employed	44	20.2	14	6.40
Trading	13	6.40	61	28.4
Farming	11	4.60	-	-
Private sector worker	12	5.50	7	2.80
Clergy	4	1.80	4	1.80
Military officer	2	0.90	-	-
Lecturing	4	1.80	2	0.90
Pensioners	12	5.50	2	0.90
Unemployed	-	-	16	7.30

Field survey data

Table 4: Fresh fish consumption among sampled households

Factors/variable	Frequency	Percentage
Consume fresh fish in your household?		
Yes	124	57.0
No	94	43.0
Total	218	100.0
Types consume		
Do not consume	94	43.0
Clarias	90	41.3
Tipia	47	22.0
Others	7	3.20
Who makes the decision to consume?		
Husband	33	15.6
Wife	83	37.6
Children	10	4.60
Others	6	2.80
Reasons for consuming fresh fish		
Palatable	39	17.4
Cheap	10	4.60
Add variety	47	21.1
Nutritious	54	24.8
Readily available	12	5.50
Hypertension	8	3.70
Diabetics	2	0.90
Others	2	0.90
Reasons for not consuming		
Too expensive	52	23.9
Health reasons	3	1.30
Cultural reasons	1	0.50
Allergy	44	20.2

Field survey data

average of ₦1, 665.97 k, ₦1, 865.05 k and ₦2, 075.09 k per month on fresh fish, frozen fish and beef respectively (Table 5). The amount spent on fresh fish represented less than 2% of household income.

Table 5: Monthly distribution of expenditures for fresh fish, frozen fish and beef among households

Expenditure range (Naira)	Frequency	Percentage
Fresh fish		
≤1,000	59	26.6
1001-2000	41	19.3
2001-3000	8	3.70
3001-4000	6	2.70
4001-5000	4	1.80
>5000	6	2.70
Mean	₦1,665.97k	
Frozen fish		
≤1,000	78	35.8
1001-2000	85	39.0
2001-3000	41	18.8
3001-4000	6	2.70
Mean	₦1,865.05k	
Beef		
≤1,000	54	24.8
1001-2000	83	38.5
2001-3000	35	15.6
3001-4000	18	8.30
4001-5000	16	7.30
>5000	12	5.50
Average	₦2,075.09k	

Field survey data; US$ 1 = ₦150 as at the time of data collection

The models' results:

Single-step process: The single step process treated both the participation and consumption processes as a single problem assuming that both participation and consumption are one process. The censored model (Tobit) used for the analysis revealed that husband income (at $\alpha = 0.01$), wife's income (at $\alpha = 0.05$) and expenditure on beef (at $\alpha = 0.05$) all positively affected consumption of fresh fish (Table 6).

Table 6: Single step, independent double hurdle and dependent double hurdle models

		Independent double-hurdle model		Dependent double-hurdle model (joint estimation)	
	Single step (truncated)	1st hurdle (participation)	2nd hurdle (consumption)	1st hurdle (participation)	2nd hurdle (consumption)
Constant	-4887.3*** (-3.33)	-2.974*** (-2.9174)	109.80 (0.095)	-1911.5** (-2.128)	-0.479* (-1.932)
Husband age	-19.4 (-0.343)	-0.0077 (-0.214)	-17.314 (-0.381)	-6.6717 (-0.201)	-0.0007 (-0.058)
Household size	-128.11 (-0.888)	-0.051 (-0.533)	-40.482 (-0.373)	-72.769 (-0.780)	0.018** (2.31)
Husband education	86.729 (1.35)	0.712* (1.919)	0.781 (0.016)	17.985 (0.451)	0.026* (1.83)
Husband income	0.127*** (2.90)	0.0000015 (0.472)	0.0124*** (4.063)	0.0122*** (4.31)	0.028** (2.267)
Wife age	77.97 (1.13)	0.0505 (1.1448)	15.73 (0.282)	34.188 (0.844)	0.0147 (0.972)
Wife's education	80.97 (1.07)	0.0579 (1.1469)	-2.169 (-0.038)	52.73 (1.103)	0.0176 (0.989)
Wife's income	0.015** (2.12)	0.0013** (2.118)	0.0082 (1.00)	-0.009* (-1.94)	0.008*** (2.77)
Expenditure on fish	0.115 (0.535)	0.00029 (0.192)	0.00038 (0.003)	0.103 (0.724)	0.094* (1.81)
Expenditure on beef	0.345** (2.163)	0.00012 (1.087)	0.289** (2.43)	0.230** (2.25)	0.0037 (0.979)
Dependency ratio	0.230 (1. 34)	0.0034 (0.945)	-0.054** (-2.65)	-0.026** (-2.15)	-0.073*** (-3.24)
LLF	-566.1	-64.366		-955.594	
LRT		16.36**	-512.66		
McFadden R^2		0.112			
Akaike Info. criteria			17.42	8.87	
Adjusted R^2			0. 39		
ρ				0. 67 ***	

Computed from field survey data; ***: Significant at 1%; **: Significant at 5%; *: Significant at 10%

Independent double-hurdle model: In the independent double hurdle model originally proposed by Cragg (1971), husband's education (at α = 0.1) and wife's income (at α = 0.05) positively affected the probability of consuming (participation) fresh fish among households. Having crossed the first hurdle of participation, husband's income (at α = 0.01) and expenditure on beef (at α = 0.05) positively affected the extent of consumption of fresh fish while dependency ratio (at α = 0.05) had a negative effect on the extent of consumption (Table 6).

Dependent double-hurdle (joint estimation) model: Firstly, the estimate of ρ that maximizes the likelihood function is 0.67 and is different from zero at 1percent level of significance. Such a relatively large and significant ρ value implies that the residuals of the first and the second hurdles (the Probit and the Tobit models) are highly correlated. This means that the joint-estimation approach is appropriate for the data and efficiency is gained by the use of the joint estimation approach. Furthermore, other model selection criteria were considered viz Akaike Information Criteria (AIC) and the Log-Likelihood Function (LLF). The AIC is a measure of the goodness of fit of an estimated statistical model. It describes the trade-off between bias and variance in model construction. The AIC not only rewards goodness of fit, but also includes a penalty that is an increasing function of number of estimated parameters. This penalty discourages over-fitting. According to Moffatt (2003), the preferred model is the one with the lowest AIC value. AIC judges a model by how close its values tend to be to the true values in terms of a certain expected values. The AIC values are only for models' ranking as their absolute values have no meaning. In the same vein, the model with the lowest LLF is the best. To this extent, the dependent double-hurdle model was the best among the three estimated. In the dependent model which was jointly estimated, husband's income (at α = 0.01), wife's income (at α = 0.1) and expenditure on beef (at α = 0.05) positively affected the probability of consuming fresh fish (participation) while dependency ratio (at α = 0.05) negatively affected the probability of participation. On the other hand, household size (at α = 0.05), husband education (at α = 0.01), husband's income (at α = 0.05), wife's income (at α = 0.05), expenditure on fish (at α = 0.01) positively affected the extent of consumption while dependency ratio (at α = 0.01) negatively affected the extent of consumption (the second hurdle). Meanwhile, it should be noted that in both the dependent and the independent double hurdle model, different sets of explanatory variables affect each hurdle i.e., participation and consumption. This underscores the importance of modeling consumption studies with possibilities of recording some zero values for dependent variables as a two-step process (double hurdle). The Censored Tobit Model employed in the single-step process revealed that only two variables were determining the two processes compressed into one single problem. This may be quite misleading as the method assumes that the same factors determine participation and consumption. The Independent Double hurdle actually performed better than the single-step process, but other factors, the dependent double-hurdle estimation performed best. In order to ensure good measure, Akaike's Information Criterion (AIC) among others was included at the foot of each column (Table 6).

Elasticity's of variables in the dependent double-hurdle model: Table 7 shows the elasticities of the

Table 7: Elasticities of variables in the dependent double-hurdle model

	Participation (probability)	Consumption (elasticity at means)
Husband age	-0.3040	-0.0552
Household size	-0.3287	-0.1328[b]
Husband education	0.2756	0.6564[b]
Husband income	0.7785[a]	0.0300
Wife age	1.3817	0.9865
Wife's education	0.7848	0.4363
Wife's income	-0.2486[a]	-0.2394[b]
Expenditure on fish	0.1826	0.0279[b]
Expenditure on beef	-0.5076[a]	-0.3416
Dependency ratio	-0.6321[a]	-0.2382[b]

[a]: elasticity of participation computed from significant coefficients; [b]: elasticity of consumption computed from significant coefficients; Computed from field survey data

variables included in the dependent double hurdle model (effect on both participation and consumption). The results shows that elasticity of husband income was 0.78 meaning that a 1% increase in husband income will bring about a 0.78% increase in the probability of consuming fresh fish in the household. The elasticities of wife's income, expenditure on beef and dependency ratio were -0.25, 0.51 and -0.632, respectively. On the other hand the elasticity of household size on extent of consumption was -0.133. This means that a 100% increase in household size will decrease the extent of household's consumption of fresh fish by 13.3%. In the same vein, the elasticity of husband income on the extent of consumption was 0.03 which implies that a 100% increase in husband's income will cause a 3% increase in fresh fish consumption. The elasticities of husband education, wife's income, expenditure on fish and dependency ratio were 0.656, -0.239, 0.0279 and -0.2382, respectively (Table 7).

The positive and negative values with respect to husbands' and wife's income respectively may be due to certain underlying behaviors among households. Although, the qualitative aspect of this study revealed that wives were the major decision makers with respect to fresh fish consumption, the positive elasticity of husband's income may imply that the wives' decisions were hinged on the husband's income level. Furthermore, the negative elasticity of wife's income may be interpreted to mean that wives with higher income prefer lesser quantity of fresh fish for the household consumption. It can therefore be inferred that households whose husbands' incomes are high are likely to have higher demand for fresh fish and may be targeted by fresh fish producers and marketers.

CONCLUSION AND RECOMMENDATIONS

The study brought out the beauty of modeling consumption as a two step process (double-hurdle modeling) thereby corroborating existing literatures on double-hurdle modeling. The deficiency of the Gragg's independent double hurdle model was the assumption that the participation and the consumption processes were independent of each other. This was flawed in this study by the significant correlation in the error terms of the first and the second hurdles. Moreover, the dependent double-hurdle model came out with the highest number of significant variables in both hurdles and with the best model fitness indicators. These underscore the importance of modeling consumption as a two-step process and the joint estimation of the two hurdles (dependent double-hurdle modeling). It is recommended that consumption of products with possibility of zero dependent variable for some respondents should be modeled as a two-step process as different sets of variables may affect decision to consume (first hurdle) and the extent of consumption or how much to consume (second hurdle). Public enlightenment should also focus on the importance of consuming fresh fish as education was identified to be an important factor affecting consumption of fresh fish. Government should encourage production of fresh fish through directional policies such as training of young graduates, provision of soft loan and subsidies on relevant inputs. These are expected to bring down prices; hence, more households would be able to afford to consume fresh fish. Finally, marketers of fresh fish may target housewives who were the major decision makers with respect to fresh fish consumption with particular attention on high income and more educated households as they are likely to respond more favorably.

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