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Determinants of Household Meat Consumption in India: Tobit Regression Estimation

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Abstract: The human body needs energy, especially proteins, for growth as well as to do work. Much of the protein requirements for humans come from the animal protein consumed by humans as meat products. The household demand for meat products is determined chiefly by the market prices of the meats, availability of meats, household income, family size, and consumer tastes, and by factors such as demographic characteristics, socioeconomic status and importantly religion as well. This paper examines the consumption of different types of meat, fish, chicken, mutton, beef, and pork in Tamil Nadu using the 68th round NSSO survey data for the year 2011-12 and applying the Tobit regression model. The Tobit regression estimates show that meat consumption in Tamil Nadu is generally inelastic, though the income and price elasticities are positive and negative respectively, and are statistically significant. Household size matters for meat consumption, whereas religion has no effect on meat consumption in general.

Keywords: Human energy, protein, meat consumption, household expenditure, income and price elasticity, Tobit regression estimation

Introduction

The human body needs protein and other nutrients such as vitamins and minerals like phosphorus, sodium, iron, and potassium for both the growth and repair of human body cells. Much of the protein requirements for humans come from the animal protein consumed by humans as meat products. A healthy person in developing countries requires an average of 35 grams of animal protein intake per day (Sichilima *et al.* 2015). Generally, the household food consumption pattern is influenced by a number of factors like economic (income and price changes), social (urbanisation leading to

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dietary changes), cultural (exotic lifestyle influences), and market development that makes new foods available (Zhou *et al.* 2005). Among these factors income and price are seen to be the most influential in determining the choice of food, especially meat, consumption pattern. The increase in consumer income in developing countries tends to induce greater changes in the composition of food consumption (Gould, 2002). At the same time, the much higher prices of mutton, fish, and chicken relative to other meats and vegetables are constraints on the required meat consumption. As a substitute, beef consumption among consumers of non-Hindus is on the rise (Gandhi and Zhang, 2010).

Nearly 73% of Indian consumers are living in rural areas and their lifestyle is changing at greater pace and large levels due to increased connectivity and availability of junk foods and delivery mechanisms. The buying behaviour of rural consumers is influenced by several factors such as socioeconomic conditions, culture, environment, literacy level, occupation, geographical location, efforts on the part of sellers, exposure to media, etc. The consumer movement in India started with middle-class citizens in urban areas and has spread among the masses in rural areas. Such a changing consumption scenario has been largely overlooked in India in the studies of consumption in India. Especially, very few Indian studies have focused on the pattern of animal product consumption by households. For instance, studies on animal product consumption in India like Sinha and Giri (1989) examine the consumption of livestock products in three states Gujarat, Punjab, and Tripura, Raghavendra *et al.* (2009) analysed the preference for and consumption pattern of meat types by individual households in Dharward, Karnataka, Jagadeesh Babu *et al.* (2010) study the meat consumption patterns of the rural households in the Chittoor district of Andhra Pradesh, and Kavithaa *et al.* (2014) investigate the seasonal variation in the consumption of meat in the Erode District of Tamil Nadu using the primary survey data.

The limited number of available Indian studies have been confined to specific regions of India and are largely primary survey-based. Moreover, they do not use quantitative methods in analysing the determinants of household meat consumption or expenditure on meat. Hence, this paper tries to fill this gap using the 68th round NSSO (2011-2012) data and applying the quantitative method of the Tobit model.

Review of Literature

Jung and Koo (2000) analysed the demand system for meat and fish products consumption in Korea, using three sets of time series data and the three-stage least squares method. The estimated results show the changing consumption pattern

between 1980 to 1998 from cereals to more livestock products, vegetables, and fruits. The demand for meat products has increased from 0.4 million metric tons in 1980 to 1.3 million metric tons in 1996 along with the growth of national income. In Korea, meat production accounted for 19 percent of total agriculture production in 1980 which has grown to 25 percent in 1996. As fish products are important sources of protein in Korea, the 1998 per capita fish product consumption was 28 kg, higher than the per capita consumption of all other meat combined (25 kg). In the empirical estimation, meat price has a significant effect on Han woos beef, pork, chicken, and fish, and an insignificant effect on imported beef, crustaceans, and molluscs. The expenditure variable is significant in the share equation for Han woo beef, imported beef, pork, and fish, and insignificant in the share equation for chicken and crustacean.

Aepli and Finger (2013) studied the influence of different meat prices, and socio-demographic and geographic variables on sheep and goat demand in Switzerland, using the Switzerland Household Expenditure Survey from 2000 to 2005 and applying the Tobit model. The estimated results show that the consumption of sheep and goat meat is determined by meat prices, total expenditure, expenditure for food, and household characteristics like the presence of children and education. Further, the results indicate that rising prices of sheep and goat meat lead to a decline in the demand for sheep and goat meat. For an increase in the price of pork, the household demand for sheep and goat meat increases by 0.38 units, suggesting that for Switzerland households, pork is a substitute but beef is complementary for sheep and goat meat. Also, the effect of total, food and meat expenditures and the socio-demographic variables are statistically highly significant. Switzerland households with higher total expenditure or higher income have elastic demand for sheep and goat meat. Importantly, education has a positive influence on sheep and goat meat consumption indicating that education plays a crucial role in the choice of healthy dietary intake as sheep and goat meat have several health benefits in comparison to other red meat.

Karli and Bilgic (2007) tried to identify the determinants of demand for red and white meat using 2003 primary data and applying the censored regression analysis. The Tobit estimates of the demand for red and white meat demand show that the total food expenditure has a significant effect on the purchase of red meat. As the price of red meat increases, its quantity decreases significantly. On the other hand, the price of white meat has a significant positive effect on the quantity demanded of red meat, but a negative effect on white quantity meat consumption. This indicates that consumers substitute white for red meat as the price of the white meat increases. The food expenditure has a significantly positive effect on the quantity consumed of the

red meat and an increase in the proportion of food expenditures in income increases the quantity of the red meat product consumed. While the red meat quantity demand is elastic with respect to the age and size of the household, the white meat quantity demand is inelastic with social, individual, and product characteristics.

Hupkova and Bielik (2009) estimate the price and income elasticity of meat demand in Slovakia using the household budget survey of the Slovak statistical data for the period 1993-2007 and applying the regression method. The data consists of yearly observations of beef, pork, and poultry consumption, the average annual consumer price of beef, pork, and poultry meat, and net income. In Slovakia, during this period, the aggregate average consumption of beef meat is 52549 tons and the beef market prices have increased ranging between 10 to 30 percent. The pork meat consumption is stable as it continues to be favored by Slovak people and the poultry production remains relatively positive with respect to other meats. The empirical results show that the beef meat demand is inelastic with respect to own price and income and the price of poultry meat has no effect on beef consumption. Further, a decline in the purchasing power of the population and a reduction in consumer subsidies have a significant effect on meat consumption in Slovakia.

Maina and Baba (2012) examine the socioeconomic determinants of ruminant meat demand in Maiduguri Nigeria using 2011 primary survey data. According to the survey, about 92% of households demand ruminant meat. Adetunji and Rauf (2012) also studied the household demand for meat in selected states in Southwest Nigeria. In the study area, for 43.7% of households, beef is the most preferred meat. Applying the Almost Ideal Demand System (AIDS) demand function for a primary dataset, the estimates show income levels and tastes of respondents influenced the type of meat preferred. The budget share of beef decreases with an increase in the price of chicken. The budget share of pork increases with an increase in the price of mutton but it decreases with an increase in its own price. The budget share of chevon, chicken and mutton also increase with an increase in their prices. The results suggest that a one percent increase in the prices of beef, cheven and chicken would result in an 8, 5, and 7 percent reduction in the quantity demanded respectively. For households in southwest Nigeria, mutton and pork are luxury goods while chicken, beef and chevon are normal goods.

Emokaro and Dibiah (2014) analysed demand for chicken, beef, and fish among urban households in Edo and Delta states of Nigeria. In these areas, chicken and meat have a sizable 20% and beef 57% budget share. The Linear Approximate Almost Ideal Demand System applied to a primary dataset shows that the total expenditure elasticity

of chicken meat is significantly positive, its own price elasticity is significantly negative, and cross-price elasticity with respect to beef is significantly positive. Salawu *et al.* (2014) examine the consumption and consumer preference for poultry meat types - broiler, cockerel, layer, and turkey - in the Ibadan metropolis, using a primary dataset and applying descriptive statistics and multinomial logit regression method. The respondents show a different level of preference for the types of poultry meat - broiler is the most preferred with 40%, followed by turkey (33.3%), layers (14.7%) and cockerel (12%). The multinomial logit regression estimates show that age, educational level, gender, availability of substitutes, appearance of meat, and taste are the significant factors that influence consumer preference for poultry meat types.

In India, Raghavendra *et al.* (2009) examine the household preference and consumption pattern of meat types while analysing the economics of meat retailing using a 2006-2007 primary survey of urban and rural households in the Dharwad district of Karnataka. The average chicken meat consumption varied from 40 gms per day to 384g per day in urban areas and 25g per day to 129g per day in rural areas. While most urban households ranked mutton first and chicken second, it is the other way around in rural areas. Both urban and rural households were assigned third and fourth ranks respectively to beef and pork. The important factors considered by urban households while purchasing meat are the nutritive value, followed by taste, freshness, tenderness, source, price, fat content, and ease of availability. In rural areas, the factors in descending order of importance are taste, nutritional value, price, freshness, source, fat content, tenderness, and ease of availability.

Jagadeesh Babu*et al.* (2010) studied the meat consumption patterns of rural households in the Chittoor district of Andhra Pradesh, using a primary survey collected in 2009. The study shows that the most preferred meat is poultry meat (70%), followed by mutton (21%), chevon (7%), and few prefer pork (1%) and beef (1%). The major reasons for consumption of meat types are taste (88%) and habituation (8.5%), and consuming chicken once a week (60.5%) followed by fortnightly (34.5percent). The majority of rural people prefer to consume mutton once a month (60.0%) followed by fortnightly (36%) because of its high cost. The frequency of consumption of chicken and mutton is attributed to individual taste, specific occasions like festivals and cost. Even though the cost of pork and beef is less compared to the cost of mutton, the poor percentage of consumption of pork and beef is attributed to religion (91.5%) followed by individual taste (6%) and less availability (2.5%).

Kavithaa *et al.* (2014) analysed the seasonal variation in the consumption of meat, in the Erode District of Tamil Nadu, using rural primary survey data. According

to the survey, the majority of people consume more meat during winter (53.33%) followed by the rainy season (35%) and only 11.66% of people prefer meat in summer. With respect to the type of meat consumed by the rural people, most prefer chicken (56.25%), followed by mutton (34.38%), fish (6.25%), and pork (3.13%).

Data and Methodology

The data used in the empirical analysis of meat consumption in India is the secondary data set related to the consumption expenditure from the 68th round (2011-2012) of the National Sample Survey Office (NSSO). The NSSO conducts the nationwide household consumer expenditure surveys at regular intervals as part of its 'rounds', each round normally of a year's duration and conducted through interviews of a random sample of households covering the entire geographical area of the country. The NSSO data contains information on consumption expenditure for nine groups of consumption items: (i) cereals and cereal substitutes, (ii) milk and milk products, (iii) edible oils, (iv) meat, fish and egg, (v) sugar, etc., (vi) other food items (spices, salt, beverages, prepared food, etc.), (vii) clothing,(viii) fuel and light, and finally (ix) other non-food items (medicine, personal care, education, transport, recreation, rents, taxes, etc.). This paper uses the meat consumption expenditure of 6646 households in Tamil Nadu from the 68th round data of NSSO collected during the period July 2011 to June 2012 by the NSSO.

Tobit Regression Method

One of the major issues in modelling household consumption is that some households in the sample might not consume some kinds of foods during the survey periods. In the 68th round of NSSO data also, there is a considerable number of households that do not consume all meats. With a sizable number of zeros in the dataset on meat consumption, the OLS estimates of household meat consumption are biased and inconsistent as there is a censoring of data at zero values. A censored regression model by maximum likelihood estimation method that deals with both zero and non-zero values of the dependent variable is the appropriate estimation procedure. Such a technique, the Tobit model, proposed by Tobin (1958), is employed widely to estimate expenditure and consumption patterns with censored data. The Tobit model is specified by a latent regression as:

$$y^* = \beta x + u \tag{1}$$

where $u \sim N(0, \sigma^2)$, y^* is a latent variable that is censored and observed for values greater than some threshold, say λ. The observed y is defined by a measurement equation:

$$y = \begin{Bmatrix} y & if\ y^* > \theta \\ \lambda y & if\ y^* \leq \theta \end{Bmatrix} \quad (2)$$

In the typical Tobit model, θ is assumed to be zero i.e. the data are censored at 0. Thus, the estimating Tobit model is specified as:

$$y = \begin{Bmatrix} y & if\ y^* > 0 \\ 0 & if\ y^* \leq 0 \end{Bmatrix} \quad (3)$$

Assuming a normal distribution of the error term u, the likelihood function for the maximum likelihood estimation of the censored regression model is specified as:

$$L = \prod_i^N \left[\frac{1}{\sigma}\phi\left(\frac{y-\mu}{\sigma}\right)\right]^{\theta} \left[(1-\phi)\left(\frac{y-\mu}{\sigma}\right)\right]^{(1-\theta)} \quad (4)$$

where θ is the censoring point. In the Tobit model, with θ = 0 and parameter rising μ as βx, the likelihood function for the Tobit model is specified as:

$$L = \prod_i^N \left[\frac{1}{\sigma}\phi\left(\frac{y-\beta x}{\sigma}\right)\right]^{\theta} \left[(1-\phi)\left(\frac{y-\beta x}{\sigma}\right)\right]^{(1-\theta)} \quad (5)$$

The log-likelihood function for the Tobit Model is specified as:

$$lnL = \sum_{i=1}^N \left\{\theta\left[-ln\sigma + ln\phi\left(\frac{y-\beta x}{\sigma}\right)\right] + (1-\theta)ln\left[(1-\phi)\left(\frac{\beta x}{\sigma}\right)\right]\right\} \quad (6)$$

In the log-likelihood function, the first part corresponds to the classical regression for the uncensored observations and the second part is relevant for the censored observation.

As Sigehnan and Zeng (1999) point out, there are three expected values from the Tobit model which is of interest:

The expected value of the latent variable

$$y^*: E(y^*) = \beta x \quad (7)$$

With censoring at 0, the expected value of

$$y: E(y|y^* > 0) = \beta x + \sigma\lambda\lambda = \frac{\phi(\beta x/\sigma)}{\Phi(\beta x/\sigma)} \quad (8)$$

where λ is the inverse mills ratio, ϕ and Φ are the marginal density and cumulative distribution functions.

The expected value of

$$y: E(y) = \Phi(\beta x/\sigma)(\beta x + \sigma\lambda) \quad (9)$$

This is the probability of being uncensored multiplied by the expected value of y conditional on y being uncensored. Given that there are three expected values, there is no consensus on the appropriate expected value. If the data is always censored, then focusing on the latent variable is not particularly useful, especially if a corner solution

model is employed. If interested in the effects of explanatory variables that may or not be censored, probably E(y) may be interesting. If interested in just the uncensored observations, probably the conditional expectation $E(y|y^* > 0)$is to be looked at.

Empirical Results

In the 2011-2012 68th round NSSO sample of Tamil Nadu, out of 6646 households, 50% of households consumed chicken meat, followed by 31% fish, 16% mutton, and 3% beef meat. Only 10 sample households in Tamil Nadu consumed pork. Table 1 presents the descriptive statistics of the variables used in the empirical analysis of meat consumption. The descriptive statistics indicate that the majority of households both in rural and urban areas of Tamil Nadu prefer chicken and mutton consumption irrespective of religious background. The average monthly per capita meat expenditure of households in Tamil Nadu is Rs.2442.84. On average, the household consumption of fish, chicken, mutton, and beef are 0.99, 0.79, 0.66, and 0.74kgs respectively and the average price of fish, mutton, chicken, and beef are Rs.101.51, 320.61, 121.19, 124.02, and 120 respectively.

Table 1: Descriptive Statistics of Variables

Variable	*Description*	*Mean*	*Std. dev.*
MPCE	Household monthly per capita consumption expenditure (Rs.)	2442.84	1981.16
Household size	No. of household members	3.67	1.65
Fish meat	Fish consumption (kg)	0.99	0.71
Mutton meat	Mutton consumption (kg)	0.66	0.37
Chicken meat	Chicken consumption (kg)	0.79	0.42
Beef meat	Beef consumption (kg)	0.74	0.32
Pork meat	Pork consumption (kg)	0.75	0.50
Fish price	Fish price (Rs.)	101.51	39.38
Mutton price	Mutton price (Rs.)	320.61	48.71
Chicken price	Chicken price (Rs.)	121.19	20.34
Beef price	Beef price (Rs.)	124.03	30.92
Pork price	Pork price (Rs.)	120.00	15.63
Hindu	If religion is Hindu=1, 0 otherwise	0.87	0.33
Muslim	If religion is Muslim=1, 0 otherwise	0.06	0.23
Rural	If the household resides in rural area=1, 0 otherwise	0.50	0.50
Urban	If the household resides in an urban area=1, 0 otherwise	0.50	0.50
Sample size	No of observations	6646	

The maximum likelihood Tobit estimates of household meat consumption in Tamil Nadu are presented in Table 2, and rural and urban Tamil Nadu separately in Table 3. The Tobit results show that the price effect is negative and the income effect is positive on meat consumption and both are statistically significant. The coefficients of monthly per capita consumption expenditure, used as a proxy for household income, have a statistically significant positive effect on the consumption of all types of meat. However, both income elasticity and own price elasticity of meat products are only marginal quantity changes. The Tobit coefficients of household size on consumption of all types of meat are significantly positive implying addition of members in a household will increase meat consumption and hence household consumption expenditure. The estimated coefficients on religion are negative but are statistically insignificant showing no impact of religion on meat consumption in Tamil Nadu.

Table 2: Tobit Estimates of Household Meat Consumption in Tamil Nadu

Variable	*Fish*	*Chicken*	*Mutton*	*Beef*
MPCE	0.007* (7.48)	0.005* (10.37)	0.004* (6.93)	0.005** (2.37)
Household size	0.111* (8.09)	0.129* (7.85)	0.087* (9.55)	0.076* (4.06)
Price	-0.004* (7.05)	-0.001** (2.44)	-0.008* (2.75)	-0.003* (2.78)
Hindu	-0.310* (5.11)	-0.006 (0.19)	-0.007 (0.89)	0.069 (0.89)
Muslim	-0.067 (0.84)	0.037 (0.87)	-0.017 (0.79)	-0.010 (1.12)
Constant	0.935* (9.87)	0.264* (3.99)	0.414* (3.55)	0.624* (3.89)
Log-likelihood	-1182.84	-828.04	-207.43	-20.63
LR chi2	160.27	457.30	106.92	22.88
Pro>chi2	0.00	0.00	0.00	0.00
Pseudo R-square	0.06	0.22	0.21	0.36
Obs.	1172	1910	623	106

Note: Absolute t-values are in parentheses. *, ** Significant at 1, 5% levels.

Table 3: Tobit Estimates of Meat Consumption in Rural and Urban Tamil Nadu

Variable	*Rural*			*Urban*		
	Fish	*Chicken*	*Mutton*	*Fish*	*Chicken*	*Mutton*
MPCE	0.002* (7.55)	0.001* (10.63)	0.006* (5.47)	0.005* (5.11)	0.003* (5.78)	0.003* (4.65)
Household size	0.117* (5.36)	0.136* (15.86)	0.089* (5.24)	0.106* (6.41)	0.122* (15.45)	0.082* (3.66)
Price	-0.002** (2.39)	-0.009 (1.56)	-0.009 (1.63)	-0.004* (7.02)	-0.001** (2.18)	-0.004 (1.11)
Hindu	-0.148 (1.47)	-0.068 (1.15)	-0.127 (1.14)	-0.418* (7.04)	0.018 (0.47)	0.028 (0.48)
Muslim	0.310** (2.05)	-0.137 (1.52)	-0.157 (1.03)	-0.262* (3.05)	0.096** (2.01)	0.052 (0.82)
Constant	0.556* (3.19)	0.198** (1.98)	0.514** (2.34)	1.049* (9.88)	0.326* (3.71)	0.229*** (1.68)
Log-likelihood	-557.801	-421.95	-163.19	-582.51	-378.85	-69.15
LR chi2	83.02	264.58	42.93	128.02	235.26	70.41
Pro>chi2	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R-square	0.07	0.24	0.12	0.10	0.24	0.34
Obs.	511	897	273	661	1013	350

Note: Absolute t-values are in parentheses. *, **, *** Significant at 1, 5, and 10% levels.

For both rural and urban samples, the Tobit coefficients of household size and monthly per capita consumption expenditure have a positive effect on all types of meat consumption and are positive and statistically significant at 1% level. The coefficients of prices are negative, but statistically significant at 5% level only for fish consumption in both rural and urban areas and insignificant in the case of mutton consumption. The coefficients of the Hindu dummy are negative for rural households and positive for urban households, but insignificant except for fish in the urban case. However, the Muslim dummy has a significant effect on meat consumption and it is significantly positive for fish demand and insignificantly negative for other types of meat demand in rural households. In urban households, The Muslim religion is associated with significant negative fish consumption a significant positive chicken consumption, and an insignificant effect on mutton consumption in the urban area of Tamil Nadu.

Conclusion

The human body needs energy, especially proteins, for growth as well as to do work. Much of the protein requirements for humans come from the animal protein

consumed by humans as meat products. The household demand for meat products such as fish, mutton, chicken, beef, and pork is determined chiefly by the market prices of the meats, availability of meats, household income, family size, and consumer tastes, and by factors such as demographic characteristics, socioeconomic status and importantly religion as well. This paper analyses the consumption of different types of meat, fish, chicken, mutton, beef, and pork in Tamil Nadu using the 68th round NSSO survey data for the year 2011-12 and employing the censored Tobit regression model. The estimated Tobit regression results indicate that meat consumption in Tamil Nadu is generally inelastic, though the income and price elasticities are positive and negative respectively, and are statistically significant. Household size matters for meat consumption, whereas religion has no effect on meat consumption in general.

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