Volume XVI Number 3, 2024

Effects of Socio-Economic and Demographic Factors on Meat Consumption Pattern in Iran: A Demand System Approach

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Abstract

Meat as one of the most important resources of protein has a special role in human nutrition. Understanding the meat consumption structure of households is essential for planning and policymaking in this regard. In this research, we studied consumption patterns of meat products including chicken, veal, lamb, and fish for households in Iran (Mashhad city) using demand system estimation. The hypothesis of this study is that chicken is a necessary goods and other types of meat are luxury goods. Given the cross-sectional nature of the data and presence of zero expenditure for some households, we used the censored demand model based on a consistent two-step approach. For this purpose, at first, four Probit models were estimated to determine the factors affecting the probability of purchasing each selected meat product. After that, the probability density function (PDF) and the cumulative distribution function (CDF) were calculated for each selected meat product, and the Almost Ideal Demand System (AIDS) considering PDF and CDF was estimated for all types of meat using a non-linear seemingly unrelated regression. Also, the effect of demographic variables on meat consumption pattern was considered in demand system. The results of expenditure elasticities confirmed the hypothesis. The highest own-price elasticity was related to veal. Based on compensated price elasticities, all types of meat were net substitutes for chicken and chicken was also a net complement for all types of meat. On the other hand, the only substitute for lamb and chicken was veal, but with compensating income effect fish also became a substitute for them. So, in the event of an increase of the price of lamb and chicken, we recommend subsidizing the consumers with low purchasing power in order to increase the diversity of consumption of protein products. This can increase the consumption of fish.

Keywords

Censored demand system, demographic variables, meat, Iran, Probit model.

Alizadeh, P., Mohammadi, H., Shahnoushi, N. and Saghaian, S. (2024) "Effects of Socio-Economic and Demographic Factors on Meat Consumption Pattern in Iran: A Demand System Approach", *AGRIS on-line Papers in Economics and Informatics*, Vol. 16, No. 3, pp. 3-15. ISSN 1804-1930. DOI 10.7160/aol.2024.160301.

Introduction

Although food consumption behavior has changed over time, meat is still an essential meal component for consumers (Grunert, 2006). Animal protein products incorporate numerous amino acids and fats, which needed for body health and growth. Due to increasing population and awareness about health and nutrition, demand for animal protein products such as red meat, fish, and chicken has increased (Al-Shuaibi, 2011). According to the Statistical Center of Iran (2023), total expenditure on all types of meat had the largest share of gross expenditure (21 %) among the food, beverage and tobacco products. Consumption of red meat in Iran, particularly in rural areas and in low-income groups compared to developed countries, is undesirable (Rahimi et al., 2014). The average global per capita consumption of red meat is about 30 to 45 kg (FAO, 2015), while the per capita consumption of red meat in Iran is about 11.1 kg (Iran Ministry of Agriculture Jihad, 2022). In recent years, the sharp rise in the price of red meat in Iran has caused a major part of the vulnerable people of the society to reduce their consumption of this type of meat and to consume other meat products (including chicken) as a substitute for it (Cheraghi and Gholipoor, 2010); so that, per capita consumption of chicken in Iran is about 33.1 kg, which is almost twice the global average (Iran Ministry of Agriculture Jihad, 2022). Despite this, fish consumption in Iran is also less than the global standard. So that, per capita consumption of fish in Iran is 10 kg, which is less than half of the global average (Sharifi Tehrani and Mahdavi Damghani, 2021). Changes in the pattern of meat consumption, in addition to the effects on the health of people, have a significant effect on other food market and the involved supply chain participants through demand for inputs (Phuong et al., 2014). Hence, investigating meat consumption pattern and consumer behavior in response to changes in price, income, and demographic variables can provide better insights for policymakers.

Household consumption expenditure analysis is one of the most important areas of economic research and the results of the estimation of the demand system can be used to forecast demand and welfare policy analysis (Wang and Bessler, 2003). The meat demand elasticity analysis shows how consumption varies when prices and income for each type of meat change (Bouyssou et al., 2024). Valid estimates of the demand elasticities are essential for public sector policy and strategic intentions at the industry level; for instance, the results of the estimation of demand elasticity can be helpful to prioritize research and development costs, predict future market conditions and evaluate tax proposals (Ulubasoglu et al., 2016). Producer decision makers in the agricultural sector and other sectors of the economy can use information obtained from these elasticities (Hupkova and Bielik, 2010). Studies elsewhere have used system analysis to investigate the demand for meat. In particular, the Almost Ideal Demand System (AIDS) has been applied in studies that targeted on demand elasticity (Zhang et al., 2018).

Lazaridis (2003) investigated meat demand system of Greek households using linear AIDS model. Their results revealed that all types of meat, including poultry, beef, lamb, and pork were normal goods, while beef and poultry were gross complements. Taljaard et al. (2004) estimated linear AIDS model for meat in South Africa. Results showed that beef and mutton were luxury goods and chicken and pork were normal goods. Jabarin (2005) estimated linear censored AIDS model for meat in Jordan and concluded that the demand for mutton and poultry was elastic whereas the demand for beef and fish was inelastic. Falsafian and Ghahramanzadeh (2012) estimated different meat demand systems in Iran and concluded that AIDS model was more consistent with the consumption behavior of Iranian households. Delport et al. (2017) investigated the demand for meat in South Africa using a linear AIDS model and concluded that chicken could be considered a luxury good. Zhang et al. (2018) studied the factors affecting meat demand in China using a linear AIDS model. Results revealed that pork had the largest price elasticity among all types of meat. Widarjono and Mumpuni Ruchba (2021) estimated meat demand system for Indonesian urban household using non-linear AIDS model and concluded that broiler chicken was most elastic to price changes and goat meat was the least elastic to price changes. Additionally, they showed that all types of meat were normal good based on the income elasticities. Also Roosen et al (2022) calculated demand elasticities for meat in Germany based on AIDS model and showed that beef and veal were luxury meat. Also, mixtures were substitutes for all other types of meat.

Due to the unfavorable amount of meat consumption in Iran, especially red meat and fish, the study of factors affecting the pattern of meat consumption, which was the main subject of the present study, could be useful in decision making and planning to improve the nutritional status of households. A review of previous studies showed that in the most of them researchers have applied a linear price index to estimate the demand system. Furthermore, in the literature on meat demand system fewer studies have considered the zero expenditure. Most of these studies have not documented the impacts of demographic factors. So, in this study, we used Translog price index which was nonlinear and provided consistent parameter estimation. Also, we accommodated observed zero expenditure values to obtain consistent parameter and elasticity estimates by using censoring approach. Another novelty of this research was that we considered the impact of demographic variables on meat consumption pattern. So the research questions of this study are: (1) what are the effects of socio-economic variables on consumer demand for various types of meat in Mashhad? (2) what are the substitution relationships between various types of meat in Mashhad? (3) how much is the expenditure elasticitiy of demand for various types of meat in Mashhad?

Materials and methods

Non-linear Almost Ideal Demand System

The AIDS model is commonly utilized in studies of household demand. A few benefits of this model include: it is obtained from a particular cost function; thus, it corresponds with the explicit preference structure, it provides a first-order approximation to each arbitrary demand system, it satisfies the principles of choice, it aggregates across individuals while the Engel curve can remain non-linear and it is consistent with recognized household expenditure data (Sulgham et al., 2006; Aung, 2022). The AIDS model proposed by Deaton and Muellbauer (1980) for a set of n goods can be shown as Equation 1:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln(\frac{x}{P_t}). \qquad (1)$$

Where w_i indicates the expenditure share of good i for each household. p_j are the prices of goods j and x is per capita expenditure on all goods included in the system (Gustavsen and Rickertsen, 2014). Also α_i, γ_{ij} and β_i are parameters to be estimated. P_t denotes the Translog price index, which is described by Equation 2 (Delport et al., 2017):

$$\ln P_t = \alpha_0 + \sum_{j=1}^{n} \alpha_j \ln p_j + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \qquad (2)$$

Due to the non-linearity of this index and the difficulty in the estimation of non-linear demand system, in most empirical studies, a linear version of the AIDS model has been applied by replacing Stone price index. However, using Stone price index in demand system leads to hard econometric and theoretical problems (Henningsen, 2017). One of these problems is the measurement error. The use of Stone price index leads to inconsistent parameter estimation (Mizobuchi and Tanizaki, 2014). Another problem is theoretical inconsistency; the symmetry restriction in AIDS model is violated if all prices are not identical (Henningsen, 2017). By inserting the Stone price index in AIDS model, the expenditure share appears on both sides of the share equation. Consequently, the correlation between the explanatory variable $\ln(\frac{x}{P_t})$ and the error term leads to a simultaneity bias (Henningsen, 2017). Thus, researchers have proposed various approaches to deal with these problems. However, the inconsistency of using Stone price index has not been completely resolved. In order to avoid these inconsistencies, in this research, we estimated the non-linear AIDS model using the Translog price index.

Demographic variables

Demographic changes of households lead to change consumption patterns of goods (Mejia and Peel, 2012). So, it is essential to consider demographic variables in demand system to estimate correct expenditure and price elasticities. If we do not consider these effects, in fact, we have assumed that households have the same demographic composition which is not true. Therefore, we have to estimate the effects of changes in price and income on demand separately for each household type. It is not possible due to scarcity of data. Also, when there is some relationship across household types, not pooling the data leads to inefficient estimates (Blow, 2003). According to Golan et al. (2001) and Dong et al. (2004), demographic variables change the intercept term in demand system. In this study, demographic variables were incorporated into demand system by Translating approach (Senia and Dharmasena, 2017):

$$\alpha_i = \rho_{i0} + \sum_{k=1}^{m} \rho_{ik} Z_k ;\ k = 1, \ldots, m \qquad (3)$$

Where, ρ_{i0} and ρ_{ik} are the parameters which should be estimated and Z_k represents the demographic factors.

Some researchers considered *household size* and *age* and *education of the household head* as demographic variables in the meat demand analysis (Phuong et al., 2014; Caro et al., 2017; Zhang et al., 2018). Moreover, *sex of the household head* (Lazaridis, 2003; Caro et al., 2017; Zhang et al., 2018), *residential location of the household* (Dhraief et al., 2012), *having kids in the household* (Caro et al., 2017; Zhang et al., 2018) and *per capita income* (Phuong et al., 2014; Zhang et al., 2018) can affect the meat consumption pattern.

In this study, we considered demographic factors such as *household size, education, age* and *sex of the household head, having kids, residential location of the household* (urban or rural) and *total expenditure on meat in household* (as a proxy of household income) in the meat demand system. We utilized these variables in two different stages of household demand analysis. First, we used *household size, education, age* and *sex of the household head* and *total expenditure on meat* in the Probit models as factors affecting the probability of purchasing each type of meat. Then, we applied *education of the household head, having kids* and *residential location of the household* along with the price variables to demand system as factors affecting each expenditure share equation.

Correction for zero expenditure

Data collected from Household Income Expenditure Survey (HIES) can consist of zero consumption for some households. The reasons for this would be the lack of accessibility of goods, lack of consumer preferences, non-affordability and low consumption (Caro et al., 2017). Using this type of data without considering censoring of the dependent variables leads to inconsistent estimation (Mhurchu et al., 2013). There are several techniques for considering censoring in a system of equations. One of the most common techniques is a two-step procedure developed by Heien and Wessels (1990) which named HW approach. The process involves estimating the Probit model to determine purchasing behavior of consumers, calculating the inverse Mills ratio (ratio of the PDF to the CDF) and its application to demand system as an added explanatory variable (Alviola et al., 2010). Shonkwiler and Yen (1999) noted that HW estimator was inherently missing the specified conditional mean function and could not be interpreted with respect of the conditional mean. Also, it has a poor performance in the Monte Carlo simulation (Tauchmann, 2010). They suggested an alternative unbiased two-step approach to deal with this problem (Coelho et al., 2010). On the basis of this approach, first, a Probit model is estimated to specify the probability that a household would purchase the related goods, and applied this model to derive the cumulative distribution function (Φ) and probability density function (ϕ) for any households. Then, these functions are used in the next step as instruments that correct for zero expenditure values in estimating demand system. The new expenditure shares after applying the information derived from the Probit model is presented as Equation 4 (Caro et al., 2017):

$$w_i^* = \hat{\Phi}_i(Z_i'\Psi_i)w_i + \delta_i\hat{\phi}_i(Z_i'\Psi_i) \quad (4)$$

Where, w_i^* shows the new expenditure share of good i for each household and w_i is the previous expenditure share as defined in the Equation 1. Also, $\Phi(Z_i'\Psi_i)$ is cumulative density function, $\hat{\phi}_i(Z_i'\Psi_i)$ is probability density function for each household and is parameter to be estimated. By inserting Equations 3 and 4 into Equation 1 and adding a stochastic disturbance term, we could obtain the censored AIDS model with demographic variables in the form of Equation 5 (Gustavsen and Rickertsen, 2014):

$$\begin{aligned} w_i = {} & \rho_{i0}\Phi(Z_i'\Psi_i) + \sum_{j=1}^{n}\gamma_{ij}\Phi(Z_i'\Psi_i)\ln p_j + \\ & + \beta_i\Phi(Z_i'\Psi_i)\ln(\frac{x}{P_t}) + \sum_{k=1}^{m}\rho_{ik}\Phi(Z_i'\Psi_i)Z_k + \\ & + \delta_i\hat{\phi}_i(Z_i'\Psi_i) + \varepsilon_i \end{aligned} \quad (5)$$

Where, w_i, p_i and x are defined in Equation 1; ρ_{i0} and $\sum_{k=1}^{m}\rho_{ik}Z_k$ are specified in Equation 3 and ε_i is disturbance term. The restrictions related to the demand theory that need to be imposed on Equation 5 include adding up, homogeneity and symmetry. These restrictions are imposed on the system as follows (Zheng and Henneberry, 2010; Gustavsen and Rickertsen, 2014):

$$\sum_{i}^{n}\rho_{i0} = 1,\ \sum_{k=1}^{m}\rho_{ik} = 0,\ \sum_{j=1}^{n}\gamma_{ij} = 0,\ \sum_{i}^{n}\beta_i = 0,$$
$$\sum_{i}^{n}\delta_i = 0. \quad (6)$$

$$\sum_{j}^{n}\gamma_{ij} = 0 \ \textit{for any } j. \quad (7)$$

$$\gamma_{ij} = \gamma_{ji} \ \textit{for any } i \textit{ and } j. \quad (8)$$

Omitting one of the n equations from the system provides these situations. Moreover, homogeneity and adding up restrictions can recover the parameters of the eliminated equation (Maganga et al., 2014). It should be noted that the meat demand system in this study was estimated in STATA software version 15.1 by using command NLSUR and selecting Iterated Feasible Generalized Non-linear Least Squares (IFGNLS) Approach[1].

Elasticities

We can calculated the expenditure elasticity (η_i), uncompensated own-price elasticity (e^u_{ii}) and uncompensated cross-price elasticity (e^u_{ij}) as Equations 9 to 11 (Golan et al., 2001; Maganga et al., 2014):

$$\eta_i = \Phi(Z_i'\Psi_i).\frac{\beta_i}{w_i} + 1 \quad (9)$$

$$e^u_{ii} = -1 + w_i^{-1}\left[\Phi(Z_i'\Psi_i).\left(\gamma_{ii} - \beta_i\left(\alpha_i + \gamma_{ii}\ln p_i\right)\right)\right] \quad (10)$$

$$e^u_{ij} = w_i^{-1}\left[\Phi(Z_i'\Psi_i).\left(\gamma_{ij} - \beta_i(\alpha_j + \sum_{j}^{n}\gamma_{ij}\ln p_i)\right)\right] \quad (11)$$

Where γ_{ii}, γ_{ij}, α_i, α_j and β_i are parameters.

[1] For more information about this method, refer to Poi (2008).

Additionally, we can compute compensated own-price elasticity (e^c_{ii}) and compensated cross-price elasticity (e^c_{ij}) as equations 12 and 13 (Jonas and Roosen, 2008):

$$e^c_{ii} = e^u_{ii} + \eta_i w_i \quad (12)$$

$$e^c_{ij} = e^u_{ij} + \eta_i w_j \quad (13)$$

Data

Mashhad is the second largest Iranian metropolis in Khorasan Razavi province with a population of 3 027 692 people (Statistics of Mashhad city, 2015). During the period of 2011-2015, Khorasan Razavi province had the largest share of the red meat production (6.22 %) after Fars province and East Azerbaijan province. Moreover, it had the largest share of chicken production (6 %) after Mazandaran province and Isfahan province (Majlis, 2016). This study was based on primary data came from Iran's Household Income Expenditure Survey in 2020. The HIES is a nationally representative household survey accomplished by Statistical Center of Iran (SCI) annually to provide information on income and expenditure for urban and rural households at regional and country level (Statistical Center of Iran, 2023). We extracted and used data for Mashhad city from this primary data which included information on 445 rural and urban households.

Results and discussion

Among all types of meat, lamb had the highest price with an average price of 9.16 USD per kg. Also, chicken had the lowest price with an average price of 2.08 USD per kg. Each household, on average, has consumed 4.85 kg chicken, 0.9 kg veal, 1.60 kg lamb and 0.74 kg fish per month. Chicken had the largest expenditure share of total expenditure on meat (40 %) and fish had the lowest expenditure share (7 %). About demographic variables, on average, 87 % of household heads were male and 86 % of households lived in urban areas. On average, 65 % of households had kids under the age of 16. The education of the household head was based on the number of grades (from 1 - elementary to 8 - graduates or higher). On average, 3.37 people lived in each household (Table 1).

Variable	Description	Mean	S.D.	Min	Max
p_1	Price of chicken (USD per kg)	2.08	0.01	1.76	2.83
p_2	Price of veal (USD per kg)	8.02	0.04	5	12
p_3	Price of lamb (USD per kg)	9.16	0.04	6	12
p_4	Price of fish (USD per kg)	4.57	0.02	2.33	6.66
q_1	Chicken consumption (kg per month)	4.85	0.14	0	16
q2	Veal consumption (kg per month)	0.90	0.07	0	11
q_3	Lamb consumption (kg per month)	1.60	0.08	0	12
q_4	Fish consumption (kg per month)	0.74	0.06	0	7
w_1	Chicken expenditure share	0.40	0.01	0	1
w_2	Veal expenditure share	0.18	0.01	0	1
w_3	Lamb expenditure share	0.35	0.01	0	1
w_4	Fish expenditure share	0.07	0.01	0	1
size	Household size (person)	3.37	0.06	1	8
sex	Sex of the household head (male=1; 0 otherwise)	0.87	0.01	0	1
res	Residence (urban=1; 0 otherwise)	0.86	0.02	0	1
kids	Kids under the age of 16 (have=1; 0 otherwise)	0.65	0.02	0	1
edu	Education of the household head (grade)	3.23	0.09	1	8
age	Age of the household head (year)	48.95	0.68	18	86
w	Total expenditure on meat (USD per month)	35.18	1.19	3.17	157.77
m	Per capita expenditure on meat (USD per month)	11.79	0.44	0.95	66.92

Source: Author's calculation

Table 1: Variables descriptive statistics for values in the sample.

Household size had a positive and significant effect on the probability of purchasing veal, and chicken. It means that increasing household size leads to increase in the probability of purchasing veal, and chicken. On the contrary, size had a negative and significant effect on the probability of purchasing lamb and fish (Table 2). The education of the household head had a positive effect on the probability of purchasing lamb, veal and fish and had a negative and significant effect on the probability of purchasing chicken. Therefore, an increase in education of the household head could influence his or her awareness of the nutritional value of red meat and fish.

Sex of the household head affected the probability of purchasing distinct types of meat. When the household head was male, the probability of purchasing veal was reduced and the probability of purchasing other types of meat was increased. Total expenditure on meat (Log transformed - lnw) had a positive and significant effect on the probability of purchasing all types of meat (Table 2). Therefore, it could be concluded that an increase in household income led to increase the probability of purchasing all types of meat. The age of the household head had a negative effect on the probability of purchasing fish and chicken and had a positive effect on the probability of purchasing veal and lamb. So, the higher was the age of the household head, the lower was the probability of purchasing fish and chicken and the higher was the probability of purchasing veal and lamb. Percentage of corrected classified and R2 indicated the goodness of fit of the models (Table 2).

After estimating Probit models, we obtained the cumulative distribution function (Φ) and probability density function (ϕ). We used the cumulative distribution function (Φ) to multiply the covariates, and probability density function (ϕ) as an independent variable in demand system.

In the second step, we estimated the AIDS model using non-linear seemingly unrelated regression (NLSUR) considering the adding up, homogeneity and symmetry restrictions. Dropping fish equation provided adding up restriction. So, we estimated the three remaining equations by Iterated Feasible Generalized Non-linear Least Squares (IFGNLS) approach. The results were presented in Table 3.

The coefficient estimates of the variable (ϕ) were significant for lamb, fish and chicken equations. Consequently, ignoring censoring led to biased parameter estimates. This revealed the importance of censoring data and using the two-step approach. As shown in Table 3, the residential location of the household had a positive effect on the expenditure share of lamb and fish and had a negative effect on the expenditure share of veal and chicken. When the household lived in urban area, the expenditure share of lamb and fish was increased and the expenditure share of veal and chicken was reduced.

However, only the effect of it on the expenditure share of lamb was significant. So, we can conclude that urban households tended to eat more lamb. The urban households paid more attention to nutrition value of meat whereas rural households tended to consume cheaper meat. These results corroborated the findings of Yıldırım and Ceylan (2008) for chicken and lamb and Sacli and Ozer (2017) for veal and lamb. Having kids in the household under the age of 16 had a positive effect on the expenditure share of lamb and veal

Variable	Veal		Lamb		Chicken		Fish	
	Coefficient	ME¶¶	Coefficient	ME¶¶	Coefficient	ME¶¶	Coefficient	ME¶¶
const†	-9.81[a]	-	-16.77[a]	-	-1.67	-	-11.33[a]	-
lnedu¤	0.07	0.03	0.14	0.05	-0.17	-0.04	0.56[a]	0.19[a]
lnsize¶	1.14[a]	0.45[a]	-1.08[a]	-0.36[a]	0.67[a]	0.17[a]	-0.38[b]	-0.13[b]
lnage§	0.18	0.07	0.33	0.11	-0.30	-0.08	-0.25	-0.08
sex	-0.45[c]	-0.18[b]	0.16	0.05	0.26	0.07	0.04	0.01
lnw††	0.71[a]	0.28[a]	1.50[a]	0.50[a]	0.26[a]	0.07[a]	1.02[a]	0.34[a]
R^2	0.33		0.56		0.17		0.38	
PCC¤¤	72.58		85.62		80.22		75.28	

Note: [a,b,c] mean error probabilities of $p \leq 0.01$, $p \leq 0.05$ and $p \leq 0.10$, respectively; †const = constant, ¤lnedu = Log transformed edu , ¶lnsize = Log transformed size, §lnage = Log transformed age, ††lnw = Log transformed w, ¤¤PCC = Percentage of Corrected Classified and ¶¶ME = Marginal effects.
Source: Author's calculation

Table 2: Parameter estimates of the Probit model.

Variable	Veal		Lamb		Chicken		Fish	
	Coefficient	S.D.	Coefficient	S.D.	Coefficient	S.D.	Coefficient	S.D.
const[†] $\hat{\Phi}_i(Z_i'\Psi_i)$	0.60[a]	0.18	0.91[a]	0.19	-1.06[a]	0.18	0.549[a]	0.16
lnp1[¤] $\hat{\Phi}_i(Z_i'\Psi_i)$	0.17[c]	0.10	-0.21[a]	0.07	0.18	0.13	-0.143	0.09
lnp2[¶] $\hat{\Phi}_i(Z_i'\Psi_i)$	-0.45[a]	0.14	0.13	0.09	0.17[c]	0.10	0.15[b]	0.08
lnp3[§] $\hat{\Phi}_i(Z_i'\Psi_i)$	0.13	0.09	0.01[a]	0.01	-0.21[a]	0.07	0.07	0.07
lnp4[††] $\hat{\Phi}_i(Z_i'\Psi_i)$	0.15[b]	0.08	0.07	0.07	-0.14	0.09	-0.08	-
lnedu[¤¤] $\hat{\Phi}_i(Z_i'\Psi_i)$	0.04	0.03	-0.01	0.02	-0.10[a]	0.02	0.07[a]	0.02
res $\hat{\Phi}_i(Z_i'\Psi_i)$	-0.07	0.05	0.09[b]	0.04	-0.03	0.03	0.02	0.03
kids $\hat{\Phi}_i(Z_i'\Psi_i)$	0.03	0.04	0.06[b]	0.03	-0.01	0.03	-0.07[a]	0.02
lnm[¶¶] $\hat{\Phi}_i(Z_i'\Psi_i)$	0.01	0.03	0.15[a]	0.03	-0.25[a]	0.02	0.10[a]	0.03
φ[§§]	0.05	0.05	0.35[a]	0.08	1.16[a]	0.06	-1.56[a]	0.09
R^2	0.39		0.73		0.76		-	
Observations	445		445		445		445	

Note: [a,b,c] mean error probabilities of $p \leq 0.01$, $p \leq 0.05$ and $p \leq 0.10$, respectively; [†]const = constant, [¤]lnp1 = Log transformed p1, [¶]lnp2 = Log transformed p2, [§]lnp3 = Log transformed p3, [††]lnp4 = Log transformed p4, [¤¤]lnedu = Log transformed edu, [¶¶]lnm = Log transformed m and = probability density function. [†††]Fish equation parameters were derived from the adding up, homogeneity, and symmetry conditions.
Source: Author's calculation

Table 3: Parameter estimates of the Almost Ideal Demand System (AIDS) model.

and had a negative effect on the expenditure share of fish and chicken. However, only the effect of it on the expenditure share of lamb and fish was significant. Therefore, households with kids under the age of 16, tended to consume more lamb and less fish. These results were consistent with Ezedinma et al. (2006) finding for veal, chicken and fish and Zhang et al. (2018) finding for veal, chicken and lamb. Red meat is an essential source of iron which is highly bioavailable. So, it is a core food in the young child's diet (Wyness, 2016). This is one of the reasons that households with kids under the age of 16 consume more veal and lamb. The education of the household head had a positive effect on the expenditure share of fish and veal and had a negative effect on the expenditure share of chicken and lamb. Although only the effect of it on the expenditure share of chicken and fish was significant. It appears that higher education of the household head leads to increase the consumption of fish and veal and reduces the consumption of chicken and lamb; these findings were in line with the results of the studies by Lazaridis (2003) and Zhang et al. (2018) for veal and chicken. Normally, consumers with high educational level are more concerned about health than others with low educational level. The positive effect of education of household head on fish expenditure share confirmed this reality.

Uncompensated and compensated own-price elasticity and cross-price elasticity along with the expenditure elasticity were reported in Table 4. We calculated these elasticities at the means of the independent variables based on estimated parameters of the AIDS model. As the results showed, the expenditure elasticity of chicken was less than one while the expenditure elasticities of lamb, veal, and fish were greater than one. So, for 1 % increase in the total expenditure on meat, the demand for veal, lamb, fish, and chicken would increase by 1.01, 1.27, 2.40 and 0.50 percent, respectively. Consequently, chicken was a normal good and veal, lamb and fish were luxury goods. So, the demand for luxury goods is highly sensitive to income changes. Among these luxury goods, fish had the highest expenditure elasticity. So, we found that consumers decided to spend the extra budget on fish than other types of meat, by increasing their income. Also, the quantity demanded of chicken (4.85 kg per month) was higher than the total demand of other meat products (3.24 kg per month) (Table 1). So, despite the fact that the expenditure on chicken increases at a lower rate with increasing income compared with the increasing rates of other types of meat, the absolute quantity of chicken demand will increase at more rapid rate compared with the quantity demanded of other types of meat. Hence, if consumer expenditure on meat increased by 10 %, the monthly average household consumption of chicken, veal, lamb and fish would be increased by 0.24 kg (4.85 × 5 %), 0.09 kg

(0.9 × 10.01 %), 0.2 kg (1.6 × 12.7 %) and 0.17 kg (0.74 × 24 %). Most veal and lamb estimated by low income region were identified as luxury goods; as income increases, the quantity demanded also increases, but at more rapid rate than the normal goods. For instance, we can mention the findings of studies conducted by Taljaard et al. (2004), Ezedinma et al. (2006), Falsafian and Ghahramanzadeh (2012) for Southern Africa, Nigeria and Iran. In contrast, in high income region veal and lamb were normal goods. In this context, we could refer to the results of the studies accomplished by Tonsor et al. (2010) and Okrent and Alston (2012) for the United States, Sheng et al. (2010) for Malaysia, Cranfield (2012) for Canada and Basarir (2013) for UAE. Also fish was a luxury good in Mashhad, this finding is consistent with the results of a previous studies by Agbola et al. (2002), Osho and Uwakonye (2003) and Falsafian and Ghahramanzadeh (2012) for Southern Africa, Nigeria and Iran. Whereas the results of the other research studies showed that fish was a normal good including Tonsor et al. (2010) and Okrent, Alston (2012) for the United States, Basarir (2013) for UAE and Nakakeeto and Chidmi (2016) for Texas.

The quantity consumed for normal goods will increase with income, but at a slower rate than the luxury goods. For the reason that, by increasing income, consumers are likely to use their increased income to purchase more luxury goods rather than buying more normal goods. Chicken was a normal good, this result is logical due to the fact that chicken was a net complement for all types of meat (Table 4) and it is an important source of protein in Iranian diet. The results of the most studies in low income and high income region have shown that chicken was a normal good including Taljaard et al. (2004), Sheng et al. (2010), Falsafian and Ghahramanzadeh (2012), Okrent and Alston (2012), Cranfield (2012), and Basarir (2013).

Each compensated and uncompensated own-price elasticity had proper negative sign. However, compensated and uncompensated own-price elasticities were only meaningful for veal and lamb. Veal had the largest uncompensated own-price elasticity (-2.19) which indicated that the demand for veal was very sensitive to price changes. Also, chicken had the lowest own-price elasticity (-0.37) which showed that it was a necessary good for households. The results

	Veal	Lamb	Chicken	Fish¤
Uncompensated price elasticities				
Veal	-2.19[a] (0.48)[†]	0.32 (0.42)	0.45 (0.43)	0.37[c] (0.2)
Lamb	0.05 (0.17)	-1.25[a] (0.1)	-0.13 (0.1)	0.01 (0.14)
Chicken	-0.1 (0.75)	-0.73[a] (0.09)	-0.37 (0.9)	-0.81 (0.71)
Fish¤	0.07 (0.39)	-0.43 (0.43)	-0.55 (0.39)	-1.27
Compensated price elasticities				
Veal	-2.02[a] (0.48)	0.67 (0.42)	0.84[b] (0.43)	0.44[b] (0.201)
Lamb	0.28 (0.17)	-0.78[a] (0.1)	0.38[a] (0.1)	0.1 (0.14)
Chicken	-0.01 (0.75)	-0.55[a] (0.09)	-0.16 (0.9)	-0.77 (0.71)
Fish¤	0.49 (0.39)	0.42 (0.43)	0.4 (0.39)	-1.09
Expenditure elasticities				
Expenditure	1.01[a] (0.08)	1.27[a] (0.06)	0.50[a] (0.03)	2.40[a] (0.28)

Note: [a,b,c] mean error probabilities of $p \leq 0.01$, $p \leq 0.05$ and $p \leq 0.10$, respectively; [†]Numbers in parentheses are standard errors. ¤Fish elasticities were derived from the adding up, homogeneity, and symmetry conditions of demand parameters.
Source: Author's calculation

Table 4: Uncompensated and compensated price elasticities, and expenditure elasticities of Almost Ideal Demand System (AIDS) model.

of the own price elasticities were similar to those reported by Jabarin (2005) and Taljaard et al. (2004) for chicken, veal and lamb, Ezedinma et al. (2006) for veal, lamb and fish, Basarir (2013) for chicken and lamb and Zhang et al. (2018) for veal and lamb. Based on uncompensated elasticities, when the price of veal rose, the demand for lamb and fish increased and the demand for chicken decreased. Therefore, lamb and fish were substitutes for veal, while chicken was a complement. As well as, Falsafian and Ghahramanzadeh (2012) and Dhraief et al. (2012) found that lamb was a substitute for veal, Ezedinma et al. (2006) showed that chicken was a complement for veal and Dhraief et al. (2012) and Basarir (2013) showed that fish was a substitute for veal. As lamb price rose, the demand for veal increased and the demand for other types of meat decreased. So, veal was a substitute for lamb and other types of meat were complements. Similar results to those reported by Falsafian and Ghahramanzadeh (2012). Basarir (2013) concluded that fish was a complement for lamb, Ezedinma et al. (2006) showed that chicken and fish were complements for lamb. Also, veal was a substitute for chicken while other types of meat were complements for chicken. This result was consistent with previous studies; Basarir (2013) found that fish was a complement for chicken, Falsafian and Ghahramanzadeh (2012) showed that lamb was a complement for chicken, Ezedinma (2006) showed that lamb and fish were complements for chicken. Falsafian and Ghahramanzadeh (2012) and Dhraief et al. (2012) concluded that veal was a substitute for chicken. Based on results of this study veal and lamb were substitutes for fish while chicken was a complement for fish. This is similar to the result of the earlier research; Falsafian and Ghahramanzadeh (2012) and Basarir (2013) pointed out that lamb was a substitute for fish. Also, Dhraief et al. (2012) showed that veal and lamb were substitutes for fish.

We can determine substitution and complementary relationships between all types of meat; since the income effect was not present in uncompensated cross-price elasticities. Based on uncompensated cross-price elasticities, veal, lamb and fish were net substitutes for chicken. Veal and fish were net substitutes for lamb and chicken was a net complement for lamb. On the other hand, lamb and fish were net substitutes for veal while chicken was a net complement for veal. Also, veal and lamb were net substitutes for fish while chicken was a net complement for fish.

Thus, we can notice that by compensating the income effect, with the increase in chicken price, households increased the consumption of lamb and fish. Also, with the increase in lamb price, they increased the consumption of veal and fish. Since chicken was a net complement for other types of meat (based on compensated and uncompensated cross-price elasticities), it was a necessary good in consumer basket of the households.

Conclusion

In order to deal with zero expenditure values, we proposed the censored demand system for the market of meat in Mashhad. Also, we calculated the expenditure and price elasticities based on estimated parameters of the AIDS model. The expenditure elasticities suggested that the absolute quantity of chicken demand would increase at a lower rate with meat expenditure increased compared with the quantity of any other types of meat. The implication was that chicken was a normal good while veal, lamb and fish were luxury goods for consumers in this city. Based on the results of the expenditure elasticities and comparing them with previous studies, we concluded that in most of the low income regions, veal, lamb and fish were luxury goods. However, in most of the high income regions, they were normal goods. The results highlighted that the only substitute for lamb and chicken was veal (based on uncompensated cross-price elasticity), while with compensating income effect (based on compensated cross-price elasticity) fish became a substitute for them too. Thus, we concluded that income policies could affect the meat consumption pattern in this region. The low consumption of fish and low expenditure share on this good (7 %) and the high nutritional value of this type of meat, we recommend to subsidize consumers with low purchasing power to increase the diversity of consumption of protein products, in the event of an increase in the price of lamb and chicken; this can increase the consumption of fish somewhat.

Regarding the fact that demographic variables have significant effect on meat consumption pattern in this city, policymakers and planners can identify the tastes and consumption pattern of urban and rural households based on the demographic composition of the households. They can use this information in decision-making and designing marketing strategies for meat products.

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