EMPIRICAL ESTIMATION OF POULTRY DEMAND IN ARMENIA

Hayrapetyan H.N.*

Abstract: The objective of this research is the estimation of the main factors that affect the average per capita poultry consumption in Armenia. The double-log model of the average per capita poultry consumption was estimated and the data for 2001-2019 years were collected. The data were mainly taken from the "Statistical Committee of the Republic of Armenia's" website and the parameter estimate for each variable was calculated using the STATA statistical software. Further analysis showed that only the average per capita real income has a statistically significant impact on the average per capita poultry meat consumption in Armenia and it is estimated as a normal good.

Keywords: Average Per Capita Poultry Consumption, Average Real Price of Poultry, Average Real Price of Beef, Average Real Price of Pork, Average Real Price of Potato, Average per Capita Real Income.

JEL Classification: C12, C13, C18, C32, C51, Q11.

1. Introduction

Meat takes a unique place in the structure of food consumption. In this group, preference is often given to poultry considering that it is relatively inexpensive and its dietary characteristics. In Armenia, poultry as such is produced and consumed in the form of chicken; meanwhile it contains a variety of other poultry products (turkey, duck etc.). In 2011, around 5.6 thousand tons of poultry was produced in Armenia, while its production was considerably higher in 1990 – around 34 thousand tones which met the domestic demand almost entirely (EDRIC 2012).

Only 30% of the poultry consumed in Armenia is domestically grown. There are 8-10 large and medium size poultry producers in Armenia. Because most poultry products are imported from the United States, Brazil and Ukraine, where poultry feed is cheaper than in Armenia, the imported product undercuts the domestic in terms of retail price. On average, 45 companies import poultry meat to Armenia (Hergnyan 2016).

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The table drawn below contains information about poultry production, import and export for 2010-2019.

Table 1: Poultry production, import and export 2010-2019 (tons)

Year	Production	Import	Export	Total resources
2019	14126.8	43209.4	-	57336.2
2018	13835.2	32875.8	73.7	46637.3
2017	10,149.3	35,233.8	-	45,383.1
2016	8,668.0	23,079.3	19.5	31,727.8
2015	13,329.3	32,237.2	55.8	45,510.7
2014	10,432.3	31,762.6	45.4	42,149.5
2013	5,882.6	31,375.8	46.5	37,211.9
2012	6,980.7	33,233.7	16.3	40,198.1
2011	5,637.8	38,684.1	-	44,321.9
2010	5,014.7	36,034.1	-	41048.8

Source: Statistical committee of the Republic of Armenia, Socio-Economic Situation of RA, 2010-2019

Figure 1: Poultry production, import and export

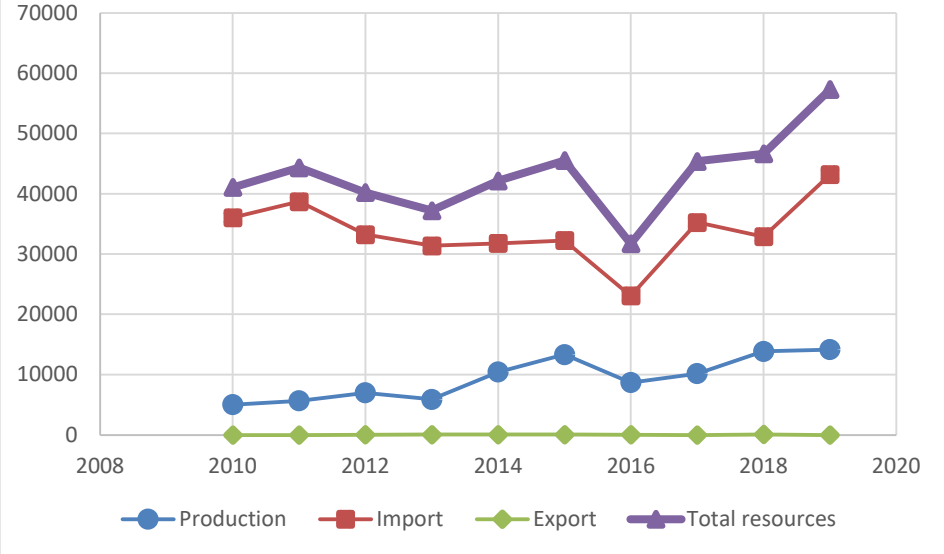

Figure above shows that total poultry resources had an increasing trend during 2010-2019. Even though production of poultry had increasing trend,

import still had a huge proportion in total poultry resources. Export quantities were negligible comparing with production and import. It was estimated that in 2019 Armenians on average would consume 19 kg poultry meat annually. This number shows that consumption of poultry is high in Armenia, and it has an important place on the average Armenian's consumption bundle. This comes from the fact that the price of poultry meat is comparatively low among other meat varieties. In 2019, the average price of poultry was 1595 AMD. In the same year, the prices of other meat varieties were fluctuating from 2250 AMD to 3789 AMD, so it is visible that poultry is more available for people with middle and low living standards. The aim of this paper is to understand "What are the key real factors that affect per capita consumption of poultry in Armenia?"

The following chapters discuss what estimations were previously done in different countries, how that models were estimated, etc. Then, we estimate the empirical model, check the model for multicollinearity, autocorrelation, specification error and afterwards, getting the estimation results make a conclusion and do recommendations for the future research.

2. Literature Review

Vedat Dagdemir in his paper about the "Estimation of Supply and Demand Models for Chicken Meat in Turkey, to determine the factors affecting the quantities supplied and demanded" has used time series data for the 1983-1998 period. It has been determined that producer price of chicken and beef affect chicken production. It was concluded that chicken producers were more responsive to the price changes than consumers. For estimating the demand for chicken meat, consumer prices of chicken meat, beef, mutton, annual income, population, and advertisement as a dummy variable were included in the model. He used double-log functional model and got the predicted signs for the parameter estimates, but the sign of parameter estimate associated with income was different. Thus, they concluded that the chicken meat is an inferior product. (Dagdemir, Demir and Keskin 2004)

The Objective of U.N Bhatti's paper of "Supply and Demand Responses for Poultry Meat in Australia" is to quantify the effects on the poultry meat sector of a recent significant change in the domestic feed wheat marketing policy. The demand per person is a function of poultry meat price, price of other meat substitutes, total consumption expenditure per person and seasonal factors. The model was constructed on a quarterly basis. The periods

chosen was 1971-1986. Two-stage least squares was used for consistent estimation of the model. The parameter estimates associated with lagged values of poultry demand and prices of substitute goods were statistically significant at the 1%, 5%, 10% significance levels and the parameter estimates associated with the real price of poultry meat, real per capita total consumption expenditure and the third quarter were statistically significant at 10% significance level. (BHATI 1987)

The next examined literature is Pakistan's case of "Empirical Estimation of the Factors Affecting Demand and Supply of Poultry Meat" by Hammad Badar. The present study was conducted to evaluate the impact of various variables affecting supply of poultry birds and demand of poultry meat in Faisalabad, Pakistan. Cross sectional data were collected from 40 poultry farmers and 40 consumers selected randomly from Faisalabad city. Simple linear model was conducted to estimate the effect of major variables. Sales price of poultry birds, average cost of production and experience of the poultry farmers significantly ($P<0.05$) affected supply of poultry birds, whereas education of farmers and distance from the markets had non-significant effect. Income of consumers, family size and retail price of poultry meat were found significant variables, whereas age and education of consumers were nonsignificant variables affecting on demand. A qualitative variable was used to capture effect of bird flu on supply and demand of poultry meat, which was found significant in both models. This finding establishes the serious implications of bird flu epidemic for poultry industry in Pakistan. (Ghafoor, et al. 2010)

3. Empirical Model

Choosing the Variables of the Model

In order to estimate the factors that affect poultry consumption in Armenia, the natural logarithm of yearly per capita consumption of poultry (ln_consp) as a dependent variable is chosen, then as explanatory variables, natural logarithms of poultry's real price (ln_Plp), beef's real price (ln_Bfp), pork's real price (ln_Prk), potato's real price (ln_Ptp) and average monthly per capita real income (ln_inc) are included in the model.

After running the regression, it was assumed that maybe ln_bfp and ln_pkp were statistically the same. The test was conducted to understand whether the natural logarithm of the average real price of beef and pork are statistically the same or not. The obtained t statistics from the formula written below equals 0.15263453.

$$t = \frac{\hat{\beta}_3 - \hat{\beta}_4}{\sqrt{var(\hat{\beta}_3) + var(\hat{\beta}_4) - 2cov(\hat{\beta}_3, \hat{\beta}_4)}}$$

As calculated t=0.15263453<$t_{critical}$=1.771, we fail to reject the null hypothesis (H_0: βln_bfp=βln_pkp) at 10% significance level and conclude that the natural logarithm of the average real price of beef and pork are statistically the same. Therefore in the model, only the price of beef is included.

Then natural logarithm of mutton real price was added and its marginal or incremental contribution was calculated to see if it was worth to add. F was calculated for marginal contribution based on the formula written below.

F = (ESSnew – ESSold/number of new regressors)/(RSSnew/df(n–number of parameters in the new model))

F=0.56361801<$F_{critical}$ =3.14 which means that the calculated F is not significant. Therefore, there is no need to add logarithm of mutton real price in the model.

The final model has the following form:

$$\ln\_consp_t = \beta_0 + \beta_1 \ln\_Plp_t + \beta_2 \ln\_Bfp_t + \beta_3 \ln Ptp_t + \beta_4 \ln\_inc_t + u_t$$

ln_consp_t is the natural logarithm of the average yearly per capita poultry consumption in time period t

ln_Plp_t is the natural logarithm of the average real price of poultry in time period t; according to the law of demand the sign of the parameter estimate associated with the log of real price of poultry is expected to be negative.

ln_Bfp_t is the natural logarithm of the average real price of beef in time period t. Since poultry and beef are considered to be substitutes, based on theory, the sign of parameter estimate associated with the log of the real price of beef is expected to be positive (increase in price of beef would cause poultry consumption to increase).

ln_Ptp_t is the natural logarithm of the average real price of potato in time period t. Since poultry and potato are considered to be complements, based on theory, the sign of parameter estimate associated with the log of real price of potato is expected to be negative (increase in price of potato would cause poultry consumption to decrease).

ln_inc_t is the natural logarithm of the average monthly per capita income at time t. Since poultry is expected to be a normal product, the sign expectation is also positive.

Choosing functional form of the model

In order to choose between a linear regression model and log-linear, the MWD (MacKinnon, White, and Davidson) test was applied. As a result the log-linear model was chosen, because it better suited to the model.

Detection of Multicollinearity

Originally, multicollinearity meant the existence of a "perfect," or exact, linear relationship among some or all explanatory variables of a regression model. But in this paper the check for multicollinearity is less than perfect. If multicollinearity is less than perfect, the regression coefficients cannot be estimated with great precision (Gujarati 2003).

Because of high R^2=0.8368, significant F and mostly all non-significant t values, it is obvious that the model has a multicollinearity problem.

Some authors use the VIF (variance inflation factor) as an indicator of multicollinearity. The larger the value of VIF, the more "troublesome" or collinear the independent variables are. As a rule of thumb, if the VIF of a variable exceeds 10, which happens when R^2 exceeds 0.90, the variable is considered to be highly collinear. Here are the results of VIFs and TOLs.

Variable	VIF	TOL=1/VIF
ln_Plp	12.52	0,079874
ln_Bfp	5.56	0,179817
ln_Ptp	2.91	0,343658
ln_inc	9.20	0,108741

As we can see from the VIF column, ln_plp is greater than 10, which means there is a multicollinearity problem in the data. For tolerance, we compare values with 0.1 (which variables are less than 0.1). Again, as TOL (1/VIF) numbers show, ln_plp is less than 0.1, which means there is multicollinearity in the data.

On the other hand, ln_plp is the core variable and it would be a major error just disregard in order to remedy the model. Moreover, specification bias problem arises in that case even estimators would not be unbiased anymore. Even in case of multicollinearity, the parameter estimates are considered to be unbiased. It is better to have all the necessary variables included in the model rather than have biased estimates. We also cannot use

first difference, because the database size is small (only 19 observations), and first difference will consume one more degree of freedom, therefore, we cannot remedy multicollinearity. In addition, multicollinearity is essentially a data deficiency problem and in this case, there is no choice over the data.

Autocorrelation problem

One of the important assumptions of the classical linear regression model is the absence of autocorrelation between the disturbances (cov [ui, uj| Xi, Xj]=0) (Gujarati 2003).

Autocorrelation in time series data can be define as correlation between members of series of observations ordered in time, the CLRM assumes that: $E(u_i u_j) = 0$, when $i \neq j$ (Gujarati 2003).

In order to check the model for autocorrelation, Run test and Durbin-Watson test were implemented.

Durbin-Watson test show that D statistic is equal to 2.37385. Number of observations is 19 (n=19) and explanatory variables are 4 (k=4). In this case d_L =0.859 at 5% significance level, d_U=1.848, 4-d_U=4-1.848=2.152, 4-d_L=4-0.859=3.141. Since 4- d_U=2.152<d=2.37<4-d_L=3.141, there is no decision, because d is in the indecision zone. Anyway, since d is close to 2, there is no serious autocorrelation in the model.

Run's test also was conducted in order to detect the existence of autocorrelation.

H_0: residuals are random

H_1: residuals are not random

Prob [1.83≤ R ≤17.11] = 0.95

Since the R=9 lies in the confidence interval (1.83; 17.11), we fail to reject the null hypothesis at 5% significance level (α=0.05) and conclude that the residuals are random. In other words, residuals do not exhibit autocorrelation. Therefore, there is no need to correct anything in the model.

Testing specification errors

The theory says, if the model is not "correctly" specified, we encounter the problem of model specification bias. In order to be assured that the model is secured from this problem, Ramsey's RESET test (H_0: model has no omitted variables) was applied for detecting whether there is misspecification in the model or not.

Based on the obtained results from STATA for this test (which are p-value for F_{stat} and F_{stat} itself), since p-value for F_{stat} is equal to 0.2405 and is greater than the predetermined significance level (5%-0.05 or even 10%-0.1), hence, we fail to reject the null hypothesis and conclude that the model has no omitted variables at 5% significance level. Thus, there is no misspecification in the model.

4. Data Description

As was mentioned above, for analysis time series data from 2001 to 2019 years were collected in order to estimate the factors affecting on the demand for poultry meat. The model was developed using the following variables:

Per capita consumption of poultry meat, the average real price of poultry, the average real price of substitutes (beef, pork), the average real price of compliment good (potato), the average per capita real income.

The prices of substitutes (AMD), compliment good (AMD), own price of poultry (AMD), average per capita real income and per capita consumption of poultry (kg/year) were taken from "Statistical Committee of the Republic of Armenia's" website (Armstat.am), from the statistical publications of "Food Security and Poverty".[1] Then the real prices, consumption and per capita real income were calculated by inflating the numbers with Consumer Price Index (CPI for income) and Producer Price Index (PPI for prices). The following table shows the summary of collected data.

Table 2: Statistical Summaries of the variables

Variable	Observations	Mean	Standard deviation	Min.	Max.
Consp	19	12	4.521	5.3	19
Plp	19	1304.105	189.763	1035	1602.8
Bfp	19	1898.579	668.284	1079.3	3062
Pkp	19	2336.684	815.769	993.6	3650.2
Ptp	19	159	49.707	93.6	268.7
Inc	19	33183.37	18426.28	9674.6	64339.3

[1] National Statistical Service of the Republic of Armenia, Publications on Food security and poverty by years. http://www.armstat.am/en/?nid=81&pthid=pov&year=&submit=Search.

Average per capita poultry meat consumption*:* The mean of the avarage per capita poultry consumption was 12 kg during 2001-2019. Meanwhile the standard deviation is 4.521 kg., so the quantity deviations are small. Minimum consuption per capita was 5.3 kg and the maximum one 19 kg. The average per capita poultry meat consumption had an increasing trend during those years.

Average real price of poultry*:* The mean of the avarage real price of poultry was 1304.105 AMD per kg. during 2001-2019. Meanwhile the standard deviation is 189.763 AMD per kg. so the price deviations are relatively small over the period.

Average real price of beef: The mean of the average real price of beef was 1898.579AMD per kg. during 2001- 2019. Meanwhile the the standard deviation is 668.284. During the period the minimum real price of beef is 1079.3 AMD and the maximum is 3062 AMD.

Average real price of pork: The mean of average real price of pork was 2336.684 AMD per kg during 2001- 2019. Meanwhile the the standard deviation is 815.769. During the period the minimum real price of pork is 993.6 AMD and the maximum is 3650.2 AMD. The average real price of pork had a cyclical increasing trend during those years.

Average real price of potato. As a compliment product, we obtained the real price of potato. The mean of the average real price of potato was 159 AMD per kg. during 2001- 2019. Meanwhile the the standard deviation is 49.707 AMD. During the period the minimum real price of potato is 93.6 AMD and the maximum is 268.7 AMD. The average real price of potato had cyclical trend during those years.

Average per capita real income*:* The mean of the average per capita real income in Armenia was 33183.37 AMD during 2001-2019. Meanwhile the standard deviation is 18426.28. Minimum average per capita real income is 9674.6 AMD and the maximum is 64339.3 AMD. The average per capita real income had an increasing trend during those years.

5. Estimation Results

The obtained OLS regression model is shown below.

Table 2: Estimation results

Number of observations =19	Coefficient	Std. error	t	P-values
$\widehat{\ln\_consp_t} = -19.6 - 0.7\ln\_Plp_t + 0.8\ln\_Bfp_t + 0.03\ln Ptp_t + 0.9\ln\_inc_t$				
Constant	-19.6	15.6	-1.26	0.228
ln_Plpt	-0.7	1.44	0.51	0.621
ln_Bfpt	0.8	0.8	0.98	0.346
ln_Ptpt	0.03	0.2	0.15	0.88
ln_inct	0.9	0.36	2.73	0.016
$R^2 = 0.8368$	$\bar{R}^2 = 0.7902$	F (4, 14) = 17.95		Pr (F>17.95) = 0.0000

As the STATA output shows, Pr(F>17.95)=0.0000<α=0.1, thus, all parameter estimates are jointly statistically significant at 10% significance level. R-squared equals to 0.8368 and indicates that 83.68% of the variation in the log of per capita poultry consumption is explained by the regression model. By looking at the individual p-values for regression parameter estimates, only the log of the average per capita monthly real income is statistically significant at 10% significance level as its corresponding p-value is less than 0.1. Meanwhile, due to the fact that p-values of the intercept coefficient and other regressors' parameter estimates are greater than 0.1, the intercept coefficient, the logs of average real prices of poultry, beef, and potato are statistically insignificant at 10% significance level.

The expected signs for the parameter estimates associated with the logs of the average real prices of poultry, beef and income match with the obtained results. The parameter estimates show elasticit because log linear model was used. Since the parameter estimate for log of the average per capita real income has positive sign and it is less than 1, poultry is considered to be a normal product. 1% increase in the average per capita real income, on average, would increase average per capita poultry consumption by 0.9%, holding everything else constant.

The parameter estimates associated with the logs of the average real price of potato do not have the expected sign due to data measurement error and regression on the mean values (Kennedy 2002). This indicates that potato is not a complement for poultry (this parameter is not even significant).

Based on the results, it is clear that the parameter estimate associated with the log of the average real price of poultry, which also shows the own-price elasticity, is equal to -0.7. It means that 1% increase in average real price of poultry, on average, would decrease average per capita poultry consumption by 0.7%, holding everything else constant. Since estimated own-price elasticity is less than 1 in absolute value, the demand for poultry is inelastic (this parameter estimate is not statistically significant and we can ignore the results). The parameter estimate associated with the log of the average real price of beef is 0.8 and the log of the average real price of potato is 0.03, which also indicate the cross price elasticity. If the average real price of beef increases by 1%, on average, the average per capita poultry consumption would increase by 0.8 % and if the average real price of potato increases by 1%, the average per capita poultry consumption would increase by 0.03% holding everything else constant (these parameter estimates also are not statistically significant and we can ignore the results).

6. Summary, Conclusions, and Recommendations

The main purpose of the research was to estimate the factors that affect per capita poultry consumption in Armenia. Double-log model was estimated based on time series data for the period between 2001-2019. In order to understand which factors have influence on per capita consumption of poultry, the following variables were taken as the explanatory variables: the logs of the average real prices of poultry, beef, potato, and the log of the average per capita real income. Among the variables, the logs of the average real prices of poultry, beef and income had the expected signs, but according to the p-values, only the average per capita real income was statistically significant at 10% significance level. So, based on the obtained results, only income has statistically significant influence on poultry consumption in Armenia and the income elasticity for poultry is equal to 0.9. This suggests that poultry is a normal product in Armenia. Therefore, if producers want to increase poultry supply, they should firstly pay attention to the forecasts of per capita real income.

For further analysis it is recommended to take quarterly data, in order to have more observations for analysis, and it also will show the existence of seasonality in poultry consumption (3-rd quarter might show higher consumption as it is national feature to makebarbeque during summer season). Also, it is recommended to use dummy variables for seasonality. Besides,

the estimators will be more precise if researchers consider the imported and locally produced poultry consumptions separately.

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ՀԱՅԱՍՏԱՆՈՒՄ ԹՌՉՆԱՄԻ ՊԱՀԱՆՋԱՐԿԻ ԷՄՊԻՐԻԿ ԳՆԱՀԱՏՈՒՄ

Հայրապետյան Հ. Ն.

Ամփոփում: Այս հոդվածի նպատակն է գնահատել այն հիմնական գործոնները, որոնք ազդում են Հայաստանում թռչնամսի՝ մեկ շնչի հաշվով միջին սպառման վրա: Ուսումնասիրության համար հավաքագրվել են 2001-2019թթ. տվյալները, և կիրառվել է թռչնամսի՝ մեկ շնչի հաշվով միջին սպառման կրկնակի լոգարիթմիկ մոդելը: Յուրաքանչյուր փոփոխականի պարամետրի գնահատումը հաշվարկվել է «STATA» վիճակագրական ծրագրի միջոցով: Հետագա վերլուծությունները ցույց են տալիս, որ Հայաստանում միայն մեկ շնչի հաշվով միջին իրական եկամուտն ունի վիճակագրորեն նշանակալի ազդեցություն թռչնամսի՝ մեկ շնչի հաշվով միջին սպառման վրա:

Բանալի բառեր. թռչնամսի՝ մեկ շնչի հաշվով միջին սպառում, թռչնամսի միջին իրական գին, տավարի մսի միջին իրական գին, խոզի մսի միջին իրական գին, կարտոֆիլի միջին իրական գին, մեկ շնչի հաշվով միջին իրական եկամուտ

ЭМПИРИЧЕСКАЯ ОЦЕНКА СПРОСА НА МЯСО ПТИЦЫ В АРМЕНИИ

Айрапетян Г.Н.

Аннотация. Целью данного исследования является оценка основных факторов, влияющих на среднее потребление птичьего мяса на душу населения в Армении. Рассчитана модель двойного логарифма среднего потребления мяса птицы на душу населения на основе данных за 2001-2019. Оценка параметров для каждой переменной была рассчитана с использованием "STATA" статистического программного обеспечения. Дальнейший анализ показывает, что только средний реальный доход на душу населения оказывает статистически значимое влияние на среднее потребление птичье мясо на душу населения в Армении и оно считается нормальным благом.

Ключевые слова: среднее потребление птичьего мяса на душу населения, средняя реальная цена на птичье мясо, средняя реальная цена на говядину, средняя реальная цена на свинину, средняя реальная цена на картофель, средний реальный доход на душу населения.