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Empirical Specification of Factors Affecting Per Capita Pork Consumption in Armenia

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ABSTRACT

The aim of this paper is to estimate the main factors affecting per capita pork consumption in Armenia. For this analysis, the log linear model of per capita pork consumption was estimated. In the analysis 17 observations were used for the period of 2001 through 2017. The data were mainly taken from websites of "Statistical Committee of the Republic of Armenia" and "Food and Agriculture Organization". The parameter estimate of each variable is calculated using STATA statistical software. Further analysis has shown that real price of beef, real price of mutton and real per capita disposable income had statistically significant impact on per capita pork consumption in Armenia.

Introduction

The pork industry plays a major role in the increasing meat production. This is due to the biological characteristics of pigs since they are the most productive among domestic animals (Davtyan, et al., 2004). Also, pork production is cost effective. Pigs are omnivorous, eat all the food used to feed farm animals, as well as food and food debris (Davtyan, et al., 2004). Pork is one of the main meat products in Armenian cuisine. It is very important to know which factors have significant influence on the demand of pork to be able to control them. Being aware of the factors which have influence on the pork demand, it will be easy to predict upcoming changes in the quantity demanded. Therefore, it will be possible to take actions for stabilizing economics in Armenia. In addition, it is interesting for farmers to see what factors influence pork consumption, for better planning and positioning their business.

The table drawn below contains information about pork production, import and export for 2011-2017.

The numbers show that pork consumption in Armenia had an increasing tendency within 2011-2017. Furthermore, local production of pork more than doubled during these years, whereas, import had the cyclical pattern. Below drawn figures will help to illustrate the data better.

Table 1. Pork production, import, export and prices during 2011-2017*

Year	Production (tons)	Import (tons)	Export (tons)	Total resources (tons)	Price (AMD)
2017	12732	7027.2	_	19759.2	3088.2
2016	12625	5659	_	18284	2645.1
2015	13971.5	6429.5	_	20401	3620.6
2014	12079	7295.8	_	19374.8	3341.3
2013	9399	8136.4	0	17535.4	3112.2
2012	6127	8261.5	0	14388.5	3456.8
2011	5482.6	5081.6	0.006	10564.2	2783.4

**Source: (Statistical Committee of the Republic of Armenia, 2011-2017).*

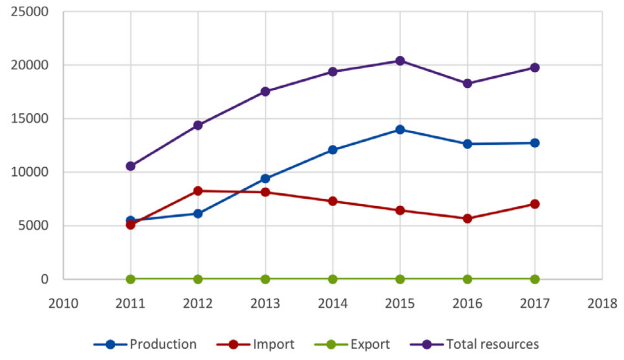

Figure 1. Pork production, import and export (*composed by the authors*).

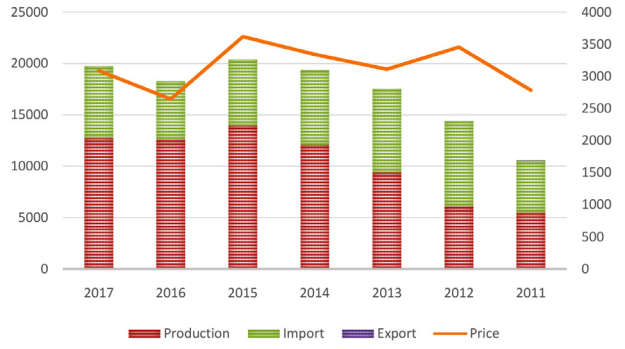

Figure 2. Proportion of import, export and production (*composed by the authors*).

After 2012 production of pork exceeds import. Major countries, which export pork into Armenia, are Brazil, Canada, Spain and Germany. Approximately 50 % of imported pork comes from Brazil (Ghazaryan, 2016, https://hetq.am/hy/article/68775). Export quantities were negligible comparing with production and import. Prices also had the cyclical pattern varying from 2645.1 AMD to 3620.6 AMD during 2011-2017.

The key research question for this paper is: "What factors are influencing per capita pork consumption in Armenia?"

All the estimations, findings and conclusions were made based on the regression analysis, which estimates whether the effect of the chosen factors on per capita pork demand are statistically significant or not.

Literature review

Sona Telunts examined the factors influencing per capita beef consumption in Armenia in her paper of "Empirical Estimation of Per Capita Beef Demand in the Republic of Armenia". She included the natural logarithm of per capita real income, the price of the beef and some complement products. She also included trend in the model, assuming that there is an increasing trend in the capita consumption of beef. Ms. Telunts estimated double-log linear regression model by using quarterly time-series data. The estimation results of her paper showed that the average real price of beef was negatively associated with the average per capita consumption of beef, besides the demand for beef was inelastic. Beef was estimated as a normal good (Telunts, 2014).

The next paper which is considered to be reliable and relevant for this study is "Elasticity of consumer demand on pork meat in the Slovak Republic" written by P. Bielik, Z. Šajbidorová in 2009. The paper examined the factors affecting the elasticity of the pork meat demand for consumers. In their model authors included the price of pork, income and some substitute products. As authors mention, the results of the analysis of the demand elasticities on the consumer level show that Slovak consumers of pork react more responsively on the change in income than on the change of the pork price (Bielik, 2009).

The next source supporting the model used in this paper is the fourth edition of "Basic econometrics" written by D. N. Gujarati. In the mentioned work the classical theorems affecting the quantity demanded of any product are presented. It claims that there are several factors affecting the consumption of the product. These factors are: income or wealth of people, price of the product, complement products, substitute product, tastes, preferences, etc. (Gujarati, 2003).

Materials and methods

Empirical Model: In this analysis the dependent variable is per capita consumption of pork (Qt). Based on theory, literature review and common sense, the independent variables that suppose to influence it are real own price of pork (rl_ppork), real prices of substitute products (rl_pbeef, $rl\_pmutton$, $rl\_ppoultry$) per capita, real monetary income (rl_pcdpi) and trend/tastes and preferences/(rl_trend).

MWD (MacKinnon, White, and Davidson) test was used to choose between linear and log-linear models. Based on the results, log-linear model is used for the further analysis.

$$\ln\_Q_t = \beta_0 + \beta_1 \ln\_rl\_ppork_t + \beta_2 \ln\_rl\_pbeef_t + \\ + \beta_3 \ln\_rl\_pmutton_t + \beta_4 \ln\_rl\_ppoultry_t + \\ + \beta_5 \ln\_rl\_pcdpi_t + \beta_6 rl\_trend_t + e_t,$$

where:

- $\ln\_Q_t$ is the natural logarithm of per capita pork consumption;
- $\ln\_rl\_ppork_t$ is the natural logarithm of real price of pork in drams. Based on the literature review we expect to have the parameter estimate associated with the real own price variable to be negative, because of the law of demand;
- $\ln\_rl\_pbeef_t$, $\ln\_rl\_pmutton_t$, $\ln\_rl\_ppoultry_t$ respectively are the natural logarithms of real prices of beef, mutton and poultry in drams. The parameter estimate associated with the substitute products' prices (beef, mutton, poultry) are expected to be positive, as if the price of substitute products has lower prices people will start to consume more of that product and less of pork. In other words, if the price of pork substitutes increases, the quantity demanded for pork will increase;
- $\ln\_rl\_pcdpi_t$ is the natural logarithm of per capita real monetary personal income in drams. Parameter estimate associated with the real per capita monetary personal income is expected to be positive, since pork is considered to be a normal good. In case of a normal good, increase in income leads to higher consumption rate;
- $trend_t$ is trend for tastes and preferences. Parameter estimate associated with the trend is expected to be positive, since we assume that when tastes and preferences go up, per capita pork consumption would also increase;
- e_t is disturbance, or error term.

Based on the used time series data, different tests were done for checking and correcting violations of OLS assumptions (multicollinearity, autocorrelation, heteroscedasticity).

At first we check, if there are omitted variables in the model or not. Ramsey test has been conducted for checking misspecification of the model. The test shows that model has no omitted variables, which means that all the necessary variables are included in the model.

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 we check for multicollinearity is less than perfect. If multicollinearity is less than perfect, the regression coefficients cannot be estimated with great precision or accuracy (Gujarati, 2003).

We suspect that there is a multicollinearity in the data, because F is statistically significant, the R^2 is very high ($R^2=0.9527$), also, there are 3 independent variables from 7 which statistically are not significant (price of pork, price of poultry and trend).

Another way to suspect multicollinearity is the pair- wise (zero-order) correlation matrix (Table 2). Not all the variables are highly correlated, but some of them have high correlation. So, we can see multicollinearity in the data.

One way to find out whether there is multicollinearity in the data is examination through partial correlations. If the coefficient of multiple correlations is high, but partial correlation coefficients are low, we can suggest that the variables are highly intercorrelated and at least one of these variables is superfluous (Table 2) (Gujarati, 2003).

Table 2. Partial correlations*

	In_rlppork	*In_rlpbeef*	*In_rl_pmutton*	*In_rl_ppoultry*	*In_rl_income*	*trend*
In_rl_ppork	1.0000					
In_rl_pbeef	0.6030	1.0000				
In_rl_pmutton	0.6924	0.8910	1.0000			
In_rl_ppoultry	-0.6199	-0.6637	-0.7581	1.0000		
In_rl_income	0.6448	0.7088	0.7872	-0.9436	1.0000	
trend	0.6063	0.7283	0.7908	-0.9494	0.9818	1.0000

Table 3. Partial correlations*

Variable	Correlation	Significance
ln_rl_ppork	0.2655	0.404
ln_rl_pbeef	0.6401	0.025
ln_rl_pmutton	-0.7685	0.003
ln_rl_ppoultry	0.4753	0.118
ln_rl_income	0.6528	0.021
trend	0.3070	0.332

Table 4. Auxiliary regression*

	R^2
Original model	0.9527
ln_rl_ppork	0.5491
ln_rl_pbeef	0.8110
ln_rl_pmutton	0.8592
ln_rl_ppoultry	0.9108
ln_rl_income	0.9692
Trend	0.9738

*Composed by the authors.

Since the R^2 is very high (0.9527), we assume that correlations between consumption of pork and independent variables need to be high. But the numbers for the real price of pork (0.2655), price of poultry (0.4753) and trend (0.3070) are very small, consequently, we can suspect that there is a multicollinearity in the data.

Another way of finding whether there is a multicollinearity issue is the auxiliary regressions. Instead of formally testing all auxiliary R^2 values, Klien's rule of thumb was adopted, which suggests that multicollinearity may be a troublesome problem only if the R^2 obtained from an auxiliary regression is greater than the overall R^2. Table 4 depicts the auxiliary regression results.

Since in the auxiliary regressions R^2 of real per capita disposable income and trend are greater than R^2 of original model, based on Klien's rule of thumb, we suspect that there is a multicollinearity in the data.

Some authors use the VIF (variance inflation factor) as an indicator of multicollinearity. The larger the value of VIF, more "troublesome" or collinear the independent variables are. As to the rule of thumb, if the VIF of a variable exceeds 10, which will happen if R^2 exceeds 0.90, that variable is considered to be highly collinear. As we can see from the VIF table drawn below, trend, *ln_rl_income* and *ln_rl_ppoultry* are greater than 10, which means there is a multicollinearity problem in the data (Table 5).

For tolerance we compare values with 0.1 (which variables are less than 0.1). Again, as TOL (1/VIF) numbers show, *trend*, *ln_rl_income* and *ln_rl_ppoultry* are less than 0.1, which means there is multicollinearity in the data.

After testing several options, we saw that the multicollinearity problem disappears when we drop trend from the model.

$$\hat{Q}_t = -11.87 + 0.10 ln\_rl\_ppork_t + 1.34 ln\_rl\_pbeef_t - 0.87 ln\_rl\_pmutton_t + 0.93 ln\_rl\_pcdpi_t$$

Table 5. Variance inflation factor*

Variable	VIF	TOL (1/VIF)
Trend	38.14	0.02622
ln_rl_income	32.43	0.033083
ln_rl_ppoultry	11.21	0.08921
ln_rl_pmutton	7.1	0.140761
ln_rl_pbeef	5.29	0.189036
ln_rl_ppork	2.22	0.450942
Mean VIF	16.07	

*Composed by the authors.

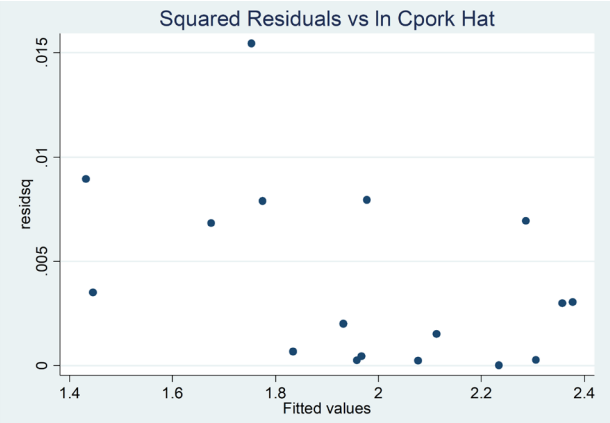

Figure 3. Residual squared against estimated per capita pork cons. *(composed by the authors).*

The new regression results show that the model hasn't multicollinearity. Although R^2 is still high, auxiliary regression shows that there is no any independent R^2 which is greater than R^2 of the model. The VIF and TOL analysis shows that all values for VIF are smaller than 10 and all values for TOL are higher than 0.1. The question arises: whether the new model is biased or not? In order to check whether regressors are biased or not, Ramsey test was conducted. The test has shown that prob (F) = 0.0296, which is less than 0.05 (5 % significance level), meaning that the model has omitted variables. So parameter estimates of the new model are biased. In this case, the decision is to reject the new model and continue the future analysis with the original model, as even in case of multicollinearity the parameter estimates were considered to be unbiased. It is better to have all the necessary variables included in the model rather than have biased estimates.

Heteroscedasticity problem: One of the important assumptions of the classical linear regression model is the assumption of homoscedasticity, or equal (homo) spread (scedasticity), that is, equal variance: $var(u_i|X_i)=\sigma^2$ (Gujarati, 2003).

Mainly heteroscedasticity is detected in cross sectional data. In 90 % cases error variance is heteroscedastic in cross sectional data. Also, heteroscedasticity is expected when heterogeneous units exist. For this paper time series data are used, and there aren't heterogeneous units, so we do not suspect heteroscedasticity in the model. To be sure whether there is heteroscedasticity in the model, we draw the scatterplot of the residual squared against estimated per capita pork consumption.

In the graph at least 1 outlier is noticed, consequently we can suspect that the error variance is heteroscedastic. To be sure Park test was applied. The test has shown that there is no heteroscedasticity in the model at 5 % significance level, since p-value for $\widehat{ln\_cpork}$ is equal to 0.083 which is greater than 0.05.

Glejser test also was conducted which proved that there is no heteroscedasticity in the model at 5 % significance level, since p-value for $\widehat{ln\_cpork}$ in this case is equal to 0.081 which is greater than 0.05.

Breusch-Pagan-Godfrey (BPG) test was applied to find out if the error variance is heteroscedastic at the 5 % significance level. Since the calculated θ is less than χ_6^2 (5.50<12.5916), there is no heteroscedasticity in the model at 5 % significance level. Finally, in order to be sure that the model is homoscedastic, White test was conducted. Since nR^2 is less than χ_{16}^2 (17.00<26.2962), we conclude that there is no heteroscedasticity in the model at 5 % significance level.

To sum up the foregoing analyses, we can state that the error variance is homoscedastic and there is no heteroscedasticity problem in the model.

Autocorrelation problem: One of the main 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 defined as correlation between members of series of observations ordered in time, the CLRM assumes that: *E(ui uj)=0, when* $i \neq j$ (Gujarati, 2003).

There are various ways of examining the residuals. The plot residuals vs Years, standardized residuals vs years, also current residuals vs residuals lagged are presented below.

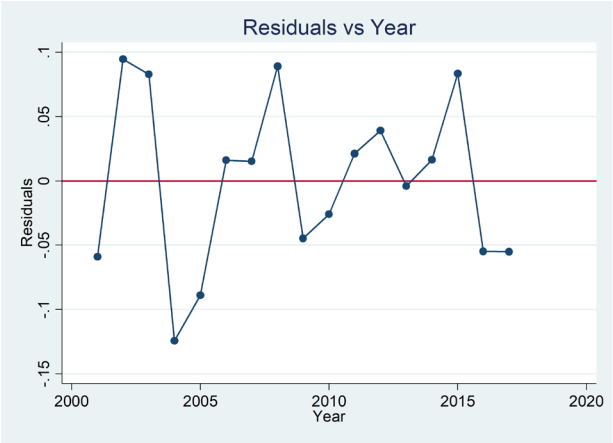

Figure 4. Residuals vs Years *(composed by the authors).*

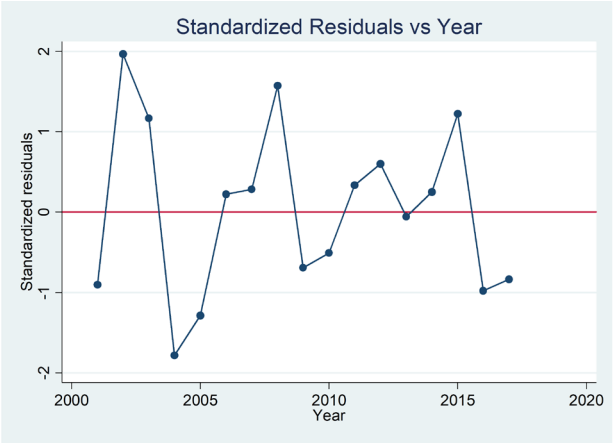

Figure 5. Standardized Residuals vs Year *(composed by the authors).*

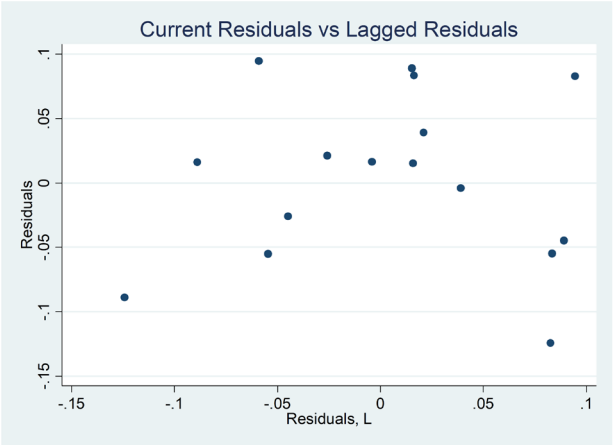

Figure 6. Current Residuals vs Lagged Resid.*(composed by the authors).*

Graphs do not show any correlation. Graph 3 shows that u's are not correlated, consequently, autocorrelation is not expected. In order to be sure, Durbin-Watson *d* test was conducted. Since d=1.899 which is greater than d_L=0.451 and less then d_u=2.537, it is unknown whether autocorrelation exists in the model or not as d is in indecision zone. That is why Run test was implemented. The 95 % confidence interval for *R* is [5.571; 13.371]. Since 95 % confidence interval contains number of runs which is equal to 8, the conclusion is that there is no autocorrelation at 95 % confidence level. Breusch-Godfrey (BG) test also proves that the model hasn't autocorrelation issue at the 5 % significance level.

Data Description

We have 17 observations for 2001-2017. The data were mainly taken from the websites of "Statistical Committee of the Republic of Armenia" and "Food and Agriculture Organization". The observations are taken annually, the mean value for the whole year. Log-linear model was used during the study. You can see the summary statistics of variables in Table 6:

Per capita consumption of pork (ln_Q): For the period 2001-2017, the mean value of per capita consumption of pork in Armenia was 7.48 kg, the standard deviation was 2.13. The minimum value for this variable is equal to 4.00 kg and the maximum value is 10.7 kg.

Real price of pork: For the period 2001-2017, the real price of pork in Armenia was 2421.55 AMD, the minimum value for real price of pork we get in 2002 (1765.63), and the maximum value in 2012 (3131.16).

Real price of beef: For the period 2001-2017, the mean value of real price of beef in Armenia was 1930.56AMD, the minimum value of the real price of beef was 1604.63 AMD and the maximum value of beef was 2304.35 AMD.

Real price of mutton: For the period 2001-2017, the mean value of real price of mutton in Armenia was 2182.46 AMD, the minimum value of the real price of mutton was 1474.19 AMD and the maximum value was 3105.80 AMD.

Table 6. Summary statistics*

Variables	Obs	Mean (kg)	Std. Dev.	Min (kg)	Max (kg)
Average per capita pork consumption	17	7.48	2.13	4.00	10.70
Average real price of pork	17	2421.55	386.20	1765.63	3131.16
Average real price of beef	17	1930.56	212.25	1604.63	2304.35
Average real price of mutton	17	2182.46	562.42	1474.19	3105.80
Average real price of poultry	17	1446.21	157.82	1193.80	1691.30
Average per capita real disposable income	17	30120.55	10270.58	14426.25	47080.52
Trend	17	9	5.04	1	17

*Composed by the authors.

Real price of poultry: For the period 2001-2017, the mean value of real price of poultry in Armenia was 1446.21AMD, the minimum value of the real price of poultry was 1193.80 AMD and the maximum value was 1691.30 AMD.

Real per capita monetary income: For the period 2001-2017, the mean value of real per capita monetary income in Armenia was 30120.55AMD, the minimum value was 14426.25 AMD and the maximum value was 47080.52 AMD.

For adjustment of prices, producer price index (PPI) was used and consumer price index (CPI)- for income.

Results and discussions

The estimation results are drawn in the table 7.

All the parameters have the expected signs, except real price of pork and real price of mutton.

Since the corresponding F statistic is equal to 33.55, which is greater than 4.06 (*F-statistic =33.55 >F8.41= 4.06*), all the parameter estimates are jointly statistically significant at the 5 % significance level. R^2=0.9527, which means that 95.27 % of the variation in the dependent variable are explained by the model. All the parameter estimates are statistically significant at 5 % significance level except price of pork, poultry and trend since their p-values are greater than 0.05. Since the log-linear model was used, the parameter estimates indicate the elasticities.

$\widehat{\beta}_3 = 1.15$: If real price of beef increases by 1 %, per capita pork consumption will increase by 1.15 %, everything else held constant.

$\widehat{\beta}_4 = -0.82$: If real price of mutton increases by 1 %, per capita pork consumption will decrease by 0.82 %, everything else held constant.

$\widehat{\beta}_6 = 0.88$: If per capita real disposable personal income increases by 1%, per capita pork consumption will increase by 0.88%, everything else held constant.

Table 7. Estimation results*

	Coeficient	Sd. Error	t	P>|t|
$lnQ_t = -18.87 + 0.16 \ln\_rl\_ppork_t + 1.15 \ln\_rl\_pbeef_t - 0.82 \ln\_rl\_pmutton_t + 1.08 \ln\_rl\_ppoultry_t + 0.88 \ln\_rl\_pcdpi_t + 0.02 trend_t$				
Constant	-18.87	6.16	-3.06	0.012
ln_rl_ppork	0.16	0.19	0.87	0.404
ln_rl_pbeef	1.15	0.44	2.63	0.025
ln_rl_pmutton	-0.82	0.22	-3.8	0.003
ln_rl_ppoultry	1.08	0.63	1.71	0.118
ln_rl_pcdpi	0.88	0.32	2.72	0.021
Trend	0.02	0.02	1.02	0.332
R^2=0.9527		*R^2 adj = 0.9243*		*F=33.55*

*Composed by the authors.

Since parameter estimate associated with real price of beef variable in absolute value is the greatest, it has the largest impact on pork consumption. Also, taking into account that own price elasticity is inelastic ($e_{op}=0.16<1$), the growth in own price will increase the revenue. But since own price of pork coefficient is not statistically significant, better not to take it into consideration. Income elasticity shows that ($e_{ip}=0.88>0$) pork is a normal good. Cross-price elasticity for beef and poultry ($e_{cp}>0$) shows that they are substitutes for pork.

Conclusion

The purpose of this paper was to estimate factors affecting per capita pork consumption in Armenia. The chosen independent variables were: real price of pork in AMD, real price of beef in AMD, real price of mutton in AMD, real price of poultry in AMD, real per capita disposable income in AMD and tastes and preferences (trend). Based on MWD test, log-linear regression model was estimated using annual data (2001-2017).

The estimation results show that the real prices of beef, mutton and per capita real monetary income had statistically significant impact on per capita pork consumption, at 95 % confidence level. The greatest effect has real price of beef. Hence, the pork producers need to pay attention to beef market. The elasticity of income shows that pork is a normal good. It is worth to note that cross price elasticities show that beef and poultry are substitute goods. So, producers need to pay attention also to these 2 products. The price of pork is inelastic.

For future researches, we recommend for more accurate conclusion taking into account quarterly data. It can help to solve the problem of multicollinearity and will allow doing estimations about seasonality of pork consumption. Considering the Armenian traditions, consumption for pork in summer and winter projected to be higher.

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