# Econometric appraisal of the demand for beef, pork and poultry in Slovenia

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**SUMMARY**

*This empirical analysis revolves around the issue of deriving the underlying trends in the demand for beef, pork and poultry meats for years 2007, 2010 and 2012, respectively. Our research rests upon the presumption of Engel law which postulates the dependence of food demand given the income available, by holding the condition of 'ceteris paribus' valid. Econometric modelling results provide the estimates of meat income elasticities of demand. Their values range between 0.1 and 0.5, thus indicating that the demand for meat in Slovenia is income inelastic. Beef, pork and poultry meats have the characteristics of normal market goods for the whole period under the scrutiny here.*

***Keywords:*** *Econometric analysis, meat demand, income/expenditure elasticities.*

## INTRODUCTION

Estimating the food demand is not a particularly novel research challenge, however there are not that many food demand studies in ex-transitional economies such in Slovenian. Most studies about analyzing food demand in Slovenia were done before 2000 (Turk, 1997; Erjavec and Turk, 1997; Turk and Erjavec, 1998). Analyzing results of demand allows us deriving income and price elasticities of food, which generally represent coherent empirical tools for agricultural policy decision making (according to Erjavec and Turk, 1998; Regoršek, 2005).

For calculating individual coefficients of income elasticity demand we need to develop econometric model. Econometric modelling approach is undoubtedly a useful methodology to analyse food sector issues. One of the earliest models in this respect has been developed by Nose (1988). In analysing the Slovene food demand time series data were used over the period of 21 years. Further econometric models have been developed between 1990 and 2000. Slovenian experts (Erjavec and Turk, 1998) were also included in developing AIDS model (Almost Ideal Demand System) which is recommended as a vehicle for testing, extending, and improving conventional demand analysis (according to Deaton and Muellbauer, 1980). One of the most recent econometric models in Slovene food sector have been developed by Hari (2012), Turk et al. (2013) and Prišenk (2015).

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In line with some relevant literature review (e.g. Gujarati, 1995) we envisage that econometric modelling approach could be useful way to estimate the demand for beef, pork, and poultry in Slovenia. The aim of this paper is to develop the statistically valid econometric function for analyzing and estimating the demand for beef, pork and poultry. We assume that coefficient values of expenditure/income elasticities will range between 0,1 and 1, which would have meant that the demand for meat in Slovenia is income inelastic.

## MATERIAL AND METHODS

### Input data collection

The time series data for the years 2007, 2010 and 2012, respectively have been collected from the Slovenian statistical office (SURS, 2014). The results of available questionnaires stem from data compilation regarding the individual household income data sets in Slovenia. The years of data collection refer to the time period before and after the financial crisis. To obtain expenditure/ income elasticities of demand, three different input data were collected: i) expenditure on the purchase of certain types of meat, ii) income per household and iii) household size. Data were collected from 1414 households, which means that 33936 individual statistical pieces of information have been compiled altogether in total.

### Model specification

To estimate expenditure/income demand elasticities, four main econometric models have been specified and tested by applying four different functional forms (linear [1], logarithmic [2], linear-logarithmic [3] and logarithmic-linear [4]). Specified regression models were used in all three years (2007, 2010 and 2012), which means 4 types of regressions on 3 types of meat for 3 yearshave been developed and estimated by using EViews 7 econometric package.

$$EXP_{beef,\ pork,\ poultry} = \beta_1 + \beta_2 INC_n + u_t \quad [1]$$
$$lnEXP_{beef,\ pork,\ poultry} = ln\beta_1 + \beta_2\ lnINC_n + u_t \quad [2]$$
$$EXP_{beef,\ pork,\ poultry} = ln\beta_1 + \beta_2\ lnINC_n + u_t \quad [3]$$
$$lnEXP_{beef,\ pork,\ poultry} = \beta_1 + \beta_2\ INC_n + u_t \quad [4]$$

Where:

$EXP_{beef,\ pork,\ poultry}$ - household expenditure for beef, pork and poultry for n-year
$\beta_1$ - constant
$\beta_2$ - parameter estimate
$INC_n$ - household income in the n-year
$u_t$ - random residual

### Model evaluation

Econometric results derived have been further evaluated given economic, statistical and econometric criteria. Econometric and statistical tests can be gleaned from Table 1, which is structured into two relevant parts.

**Table 1.** Evaluation tests for estimating econometric regression models (according to Turk et al., 2013; Prišenk, 2015).

| Purpose of the test | Name of the test | Acronym | Optimal values |
|---|---|---|---|
| **Statistical evaluation tests – part 1** | | | |
| Statistical significance | Standard error | Std. Error (S.E.) of regression coefficient | Low values which are inversely proportional with t- test values |
| | Gossett t - test | T-test | Near 2 |
| The explanatory power of econometric regression models | Standard error of regression | S.E. of regression | Low values of S.E. which areinversely proportional with t-test values |
| | Multiple determination coefficient | R-Squared ($R^2$) | Near 1 |
| | Adjusted multiple determination coefficient | Adjusted R-Squared ($R^2_{adj}$) | Near 1 |
| **Econometric evaluation tests – part 2** | | | |
| Autocorrelation | Durbin-Watson test | DW test | 1.8 – 2.2 |
| Heteroscedasticity | Gossett t - test | T-test | ~2 |
| Multicollinearity | Regression between two variables | | 0-0.5 |

## RESULTS AND DISCUSSION

After estimating the models the most appropriate model has been selected for particular type of meat, and for each year. This would in turn imply that models selected did not suffer from perfect multicollinearity, there was no high degree of heteroscedasticity and no autocorrelation to be traced. Twelve econometric models altogether were used here to derive elasticity estimates.

### Selected econometric models for pork

The estimated models for individual years (2007, 2010 and 2012, respectively) with statistical and econometric tests values for pork (fresh or frozen) are presented in Table 2.

**Table 2.** Selected econometric models for pork

| Models with Values of Std. errors and T-stat tests | | | Equation No. | Values of econometric and statistical tests* |
|---|---|---|---|---|
| $lnEXP_{pork2007} = 5.0472 + 0.04447\ (INC_{2007})$ | | | [5] | $D.W. = 2.04$ $F\text{-}stat = 1.4724\ (0,308)$ |
| Std. Error | (0.4257) | (0.3089) | | |
| T-stat (prob) | (0.0000) | (0.3089) | | |
| $lnEXP_{pork2010} = 304.929 + 0.0018\ (INC_{2010})$ | | | [6] | $D.W. = 1.97$ $F\text{-}stat = 3.8513\ (0,05)$ |
| Std. Error | (23.864) | (0.0009) | | |
| T-stat (prob) | (0.0000) | (0.0499) | | |
| $lnEXP_{pork2012} = 3.6856 + 0.1813\ (INC_{2012})$ | | | [7] | $D.W. = 1.99$ $F\text{-}stat = 24.509\ (0,000)$ |
| Std. Error | (0.3635) | (0.0036) | | |
| T-stat (prob) | (0.0000) | (0.0000) | | |

Note: *Coefficient of determination (R2) not shown here due to its relative low value which is not important in studies dealing with similar research topics as stated by Gujarati (1995) and shown by Turk (1997).

## Selected econometric models for beef

The most appropriate models for the years 2007 and 2010 proved to be logarithmic models [8] and [9], while for the 2012 [10] the most suitable model is linear regression model (Table 3).

**Table 3.** Selected econometric models for beef

| Models with Values of Std. errors and T-stat tests | | | Equation No. | Values of econometric and statistical tests* |
|---|---|---|---|---|
| $lnEXP_{beef2007} = 3.07594 + 0.2379\ (INC_{2007})$ | | | [8] | D.W. = 2.02<br>F-stat = 45.008 (0.000) |
| Std. Error | (0.3466) | (0.0355) | | |
| T-stat (prob) | (0.0000) | (0.0000) | | |
| $lnEXP_{beef2010} = 250.5703 + 0.002584\ (INC_{2010})$ | | | [9] | D.W. = 2.01<br>F-stat = 13.9511 (0.0002) |
| Std. Error | (18.3171) | (0.0007) | | |
| T-stat (prob) | (0.0000) | (0.0002) | | |
| $lnEXP_{beef2012} = 310.6883 + 0.02374\ (INC_{2012})$ | | | [10] | D.W. = 2.04<br>F-stat = 1.4724 (0.308) |
| Std. Error | (24.178) | (0.00082) | | |
| T-stat (prob) | (0.0000) | (0.0040) | | |

Note: *Coefficient of determination (R2) not shown here due to its relative low value which is not important in studies dealing with similar research topics as stated by Gujarati (1995) and shown by Turk (1997).

## Selected econometric models for poultry

Logarithmic models clearly bring about most convincing result estimates given the statistical and econometric validation criteria (Table 4).

**Table 4.** Selected econometric models for poultry

| Models with Values of Std. errors and T-stat tests | | | Equation No. | Values of econometric and statistical tests* |
|---|---|---|---|---|
| $lnEXP_{polutry2007} = 1.1793 + 0.3264\ (INC_{2007})$ | | | [11] | D.W. = 1.80<br>F-stat = 57.1311 (0.000) |
| Std. Error | (0.3770) | (0.0432) | | |
| T-stat (prob) | (0.0018) | (0.0000) | | |
| $lnEXP_{polutry2010} = 3.1662 + 0.1979\ (INC_{2010})$ | | | [12] | D.W. = 2.00<br>F-stat = 50.9732 (0.000 |
| Std. Error | (0.3126) | (0.0316) | | |
| T-stat (prob) | (0.0000) | (0.0000) | | |
| $lnEXP_{polutry2012} = 3.2301 + 0.19817\ (INC_{2012})$ | | | [13] | D.W. = 2.05<br>F-stat = 54.3901 (0.000) |
| Std. Error | (0.2681) | (0.0268) | | |
| T-stat (prob) | (0.0000) | (0.0000) | | |

Note: *Coefficient of determination (R2) not shown here due to its relative low value which is not important in studies dealing with similar research topics as stated by Gujarati (1995) and shown by Turk (1997).

After the model evaluation processes income elasticity demand or expenditure for all econometric models (for [5] to [13] equation) were calculated from equations in Table 5. On the one hand, the coefficients for income elasticity of expenditures are increasing during the observed period which means that demand for pork meat becomes more sensitive to the income changes. On the other hand, the expenditure elasticities coefficients for beef and poultry meat are not within the expected range and tend to decrease from 2007 to 2012. An increase in income for 2% in 2012 means that expenditure for beef meat will rise by 0.32%, while in 2010 the income increase for 2% means that expenditure for beef meat will enhance by 0.48%. The inelastic demand can also be observed for poultry meat (Table 6).

**Table 5.** Equations for elasticity calculation

| Type of regression | FORM | Equation elasticity |
|---|---|---|
| Linear | $y = a + b1x$ | $b1*(x´/y´)$ |
| Logarithmic | $lny = a + b1lnx$ | $b1$ |
| Logarithmic-Linear | $lny = a + b1x$ | $b1*x´$ |
| Linear-Logarithmic | $y = a + b1lnx$ | $b1*(1/y´)$ |
| Reciprocal | $y = a + b1(1/x)$ | $-b1*(1/x´y´)$ |

Note: x´y´- mean values

**Table 6.** Calculated expenditure elasticity coefficients for selected econometric models

| Selected econometric model | Expenditure elasticity coefficient | Year | Type of meat |
|---|---|---|---|
| LOG | 0.04 | 2007 | |
| LIN | 0.12 | 2010 | Pork |
| LOG | 0.18 | 2012 | |
| LOG | 0.24 | 2007 | |
| LOG | 0.20 | 2010 | Beef |
| LIN | 0.16 | 2012 | |
| LOG | 0.33 | 2007 | |
| LOG | 0.20 | 2010 | Poultry |
| LOG | 0.20 | 2012 | |

## CONCLUSIONS

The value of the determination coefficient is very low, but this does not affect the final selection of regression model, since other statistical tests are very favourable. The values of calculated expenditure elasticity coefficients range between 0.1 and 0.5, which means the analyzed type of meats have the features of normal goods. This relatively finding is in congruity with some similar studies, while some statistical and econometric outcomes corroborate with the empirical results previously obtained (Nose, 1988; Turk, 1997). Results indicate the inelastic to income changes for all types of meat in Slovenia. The pork, beef and poultry meats found to be normal goods in Slovenia and consumers are obviously reluctant to alter their meat consumption habits given their income changes (salary increases). Empirical results derived here also show that recent financial crisis has not carried any significant corresponding impacts pertaining to the meat consumption patterns exhibited by Slovene consumers.

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