

CONSUMER DEMAND FOR WINE AND BEER IN THE CZECH REPUBLIC, AND THEIR MUTUAL INFLUENCES

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Abstract

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The paper analyses consumer demand for wine and beer in the Czech Republic in the period of 1991–2013. The objective of this research was to evaluate the elasticity of consumption of wine and beer in reaction to a change of prices and further to a change in the level of a household income. Based on the dynamic models of the gross demand for wine and beer there were determined the coefficients of direct and cross price elasticity, and income elasticity coefficients. In accordance with the identified sizes, respectively, after evaluating their statistical significance, there was carried out the economic analysis of observed demand functions. Analysis of demand functions has shown that the consumptions of wine and beer by the Czech households were not linked on a statistically significant level, in the examined period. Dynamic model of the gross demand for wine showed a statistically insignificant sensitivity of wine consumption to a change of the household income. Wine consumption of Czech households was significantly formed only by its price. Dynamic model of the gross demand for beer has shown that beer consumption by the Czech households responded significantly only to change in household income. Whereas in the case of wine, there was identified an influence of previous consumption on the current one, this was not confirmed in the case of beer.

Keywords: consumption of wine, beer consumption, gross consumer demand, price elasticity of demand, income elasticity of demand

INTRODUCTION¹

Consumption of beer and wine in Bohemia and Moravia can be considered historically traditional. In terms of annual consumption of alcoholic beverages per capita, the Czech Republic holds at the forefront of European countries. According to WHO statistics for 2005, the Czech Republic was second in terms of total annual consumption of pure alcohol per person (16.45 litres). According to

the latest figures released by the Czech Statistical Office, in 2013 the annual consumption of pure alcohol per capita in the Czech Republic was 9.8 litres², which represented the total annual consumption of alcoholic beverages in the amount of 172.3 litres per capita. Wine represented 18.8 litres of this amount, beer 147 litres, and spirits 6.5 litres. Expressed in terms of pure alcohol, wine represented 22% of total consumption per capita, beer 51%, and spirits 27%.

1 Introduction was elaborated based on CSO data, report of the National Institute of Public Health (NIPH, 2013), and Žufan (2007).

2 The WHO database includes the total annual consumption of alcohol per person older than 15 years of age, whereas the CSO monitors the total annual consumption per inhabitant, i.e. including infants.

Survey of the National Institute of Public Health (2013), which took place in the autumn of 2012 through 1800 respondents³, revealed comparable results in the area of alcohol consumption. According to the survey, per capita consumption in the Czech Republic reached almost 7.5 litres of pure alcohol in 2012. Beer accounted for 58% (4.3 litres of pure alcohol), wine for 30% (0.9 litres), and spirits for 12% (2.2 litres). The survey also found that a significantly higher consumption is noted within the male population that consumed 11 litres of pure alcohol per person, in the given year. In this case the share of beer was 65%, wine 22%, and spirits 13%. Consumption of women was significantly lower, in the year 2012, namely 4.1 litres of pure alcohol per capita, which was made up of 39% of beer, 49% of wine, and 12% of spirits. In terms of age the highest consumption of alcohol was identified in the age group of 15–24 years (8.9 litres per person per year), and the lowest in the group older than 65 years of age.

From the long-term development perspective, it can be stated that since 2005 the Czech Republic shows a decrease in the total annual consumption of alcoholic beverages. When comparing data from 2005 and 2013 we see the decrease in total consumption of alcoholic beverages in the Czech Republic of almost 16 litres per person per year. This downward trend is a result of the decline in consumption of beer and spirits, with the annual beer consumption per capita decreased between 2005 and 2013 of about 16.5 litres, and 1.3 litres decline in spirits. On the contrary, there has been an increase of consumption of wine, which has been noted since 1991, when its consumption was 14.8 litres, 4 litres less than in 2013. Longer-term decline in the total consumption of alcoholic beverages is also evident in other European countries (see development of the beer consumption in Germany, Denmark and Belgium, or wine consumption in France, Italy and Spain). General decline in the annual consumption of spirits does not even need to be emphasized.

Authors of this paper focused on the economic aspects of the wine and beer consumption in the Czech Republic. Price and income determinants of consumption of alcoholic beverages has been partly addressed in other studies, as well, e.g. by Heien and Pomelli (1989), Chaloupka *et al.* (2002), Baltagi and Griffin (2002), Gallet (2007), Fogarty (2008) or Sousa (2014). These studies, though, do not pay primary attention to cross influences among different categories of drinks. Within the Czech Republic, the analysis of economic factors influence on the consumption of wine, beer or spirits is available in the articles of Chládková (2004), Pyšný

et al. (2007), Chládková *et al.* (2009) or Syrovátka, (2014). The Czech studies are also mostly focused on analysis of the consumer behaviour rather than demand interactions, i.e. evaluation of substitution and complementarity relationships among alcoholic beverages. Presented article attempts to fill this gap in given area of demand functions.

The aim of the research was to evaluate the sensitivity of wine and beer consumption to the price changes, and to the changes in the level of household income in the period 1991–2013. More specifically, the aim of given demand analysis was to quantify the coefficients of direct (own) and indirect (cross) price elasticity and income elasticity. Based on the obtained values of these elasticity coefficients, there was performed an economic analysis of studied demand functions. Special emphasis in this demand analysis was put on the evaluation of cross-price effects within the consumption of both kinds of the alcoholic beverages, thus assessing mutual interactions in their consumption by the Czech households. For the purposes of these analyses there was used a pair of symmetric models of the gross demand functions. Proposed models for the investigated consumer demands differed only in the explained variables. In both demand models, the set of explanatory variables included the wine price, beer price, and the household income. Besides the traditional determinants of demand relations, both models also included a trend component, i.e. gross demand models were explicitly dynamic. Regression models of the gross demand for the wine and beer were formulated in the log-linear form, enabling immediate estimates of the examined coefficients of the demand elasticity, and at the same time enabling an assessment of their statistical significance.

DATA AND METHODS

Data for the investigation of economic aspects of the wine and beer consumption by the Czech households was obtained from the database of the CSO (www.czso.cz). These included the time series of the total⁴ annual consumption of wine and beer by the Czech households in the period of 1991–2013. These data sets are available in the publication 320181-14: Czech Republic since 1989 in numbers. The same publication also includes the time series of prices of white “quality wine” (wine made of grapes without a sugar addition), and the time series of prices of KEG beer. The time series of annual incomes of the Czech households were taken from evidence of the Household budget survey database, item Net cash incomes total. Time series of these incomes for the period 1991–2003 were obtained from publications 3011-05: Retrospective data

3 It was based on the WHO methodology – questionnaire survey.

4 In records of the total wine consumption, it is not differentiated the colour or quality-class, and within the total beer consumption it is not differentiated packaging or type of beer (light, dark, special etc.).

statistics of family accounts for the period 1989–2003. Incomes data for 2004 and 2005 were identified individually from publications 3001-05 and 3001-06, see Incomes, Expenditures and Consumption of Households according to Household budget survey for 2004, Part I – Social Groups, Income zones, respectively Income, Expenditures and Consumption of Households according to Household budget survey for 2005, part I – Social groups, Income zones. The time series of net cash incomes of the Czech households between 2006 and 2013 were taken from the publication 160018-14: Expenditures and Consumption of Households, Household budget survey for 2013 – Households by status of head, municipality size, income zones, and cohesion regions.

In relation to the contents of the obtained time series, the following variables were defined for research of the consumption of wine and beer by Czech households:

QW_t	consumption of wine per capita in the Czech Republic in year t (litres),
QB_t	consumption of beer per capita in the Czech Republic in year t (litres),
PWW_t	price of one litre of white “quality wine” in year t (CZK/litre),
PCB_t	price of 0.5 litre of draft beer in year t (CZK/litre),
M_t	net annual income per one household member in in the Czech Republic (CZK),
$t; t = 1, 2, \dots, 23$	dummy variable capturing consumption trend or influence of other determinants of given consumption.

For the purposes of the performed demand research, authors developed and applied two symmetrically coupled dynamic models of the gross demand, which both contain parameters capturing direct price sensitivity, cross-price sensitivity and income sensitivity; see Nicholson (1992), Chládková (2005), Pyšný *et al.* (2007), or Chládková (2009). Besides the economic variables there was also incorporated the linear trend function, which is recommended when the analysis based on time series; see Pindyck and Rubinfeld (1998). This function can than expresses the development trend in the consumption of a good, or indirectly captures the effect of other factors of the simulated demand relations; see Hušek (1999). For the examination of elasticity of the wine consumption there was used a dynamic log-linear model of gross demand:

$$\ln QW_t = [a_w + b_w \times t] + c_w \times \ln PCB_t + d_w \times \ln PWW_t + e_w \times \ln M_t + u_{wt}, \quad (1)$$

and for the exploration of the elasticity of beer consumption then gross demand model:

$$\ln QB_t = [a_b + b_b \times t] + c_b \times \ln PWW_t + d_b \times \ln PCB_t + e_b \times \ln M_t + u_{bt}. \quad (2)$$

Parameters in the econometric models of wine consumption (1) and beer consumption (2) were estimated with the help of the OLS method.

Through parameters of single-equation model of the gross demand for the wine (1) and for the beer (2) there were calculated the cross price elasticity coefficients. For the cross elasticity of consumption of wine while changing the price of beer, the log-linear model specification (1) implies:

$$\varepsilon_{WB} = c_w. \quad (3)$$

The value of the coefficient of cross price elasticity of the beer consumption when changing the price of wine is, within the definition of the gross demand model (2), equal to:

$$\varepsilon_{BW} = c_b. \quad (4)$$

Based on the demand models (1) and (2) there was also quantified own price elasticity and income elasticity of the consumption of wine and beer. In accordance with the log-linear specification of demand model (1), the coefficient of the own-price elasticity for the wine consumption equals:

$$\varepsilon_{ww} = d_w \quad (5)$$

and the coefficient of income elasticity of wine consumption is:

$$\eta_w = e_w. \quad (6)$$

The coefficient of own-price elasticity of the beer consumption by the Czech households according to applied the gross demand model (2) equals:

$$\varepsilon_{BB} = d_b \quad (7)$$

and the coefficient of income elasticity of consumption of beer has a value of:

$$\eta_b = e_b. \quad (8)$$

Before economic application (economic verification), the estimated econometric models of the gross consumer demand for wine (1), and for beer (2) were firstly examined from the position of their statistical significance; see Pindyck and Rubinfeld (1998) or Hušek (1999). Attention was paid to the statistical significance of their parameters: T-tests⁵. Evaluation also included the value of the coefficient of multiple determination: R^2 , including an examination of its statistical significance:

5 Due to the differentiation of the years within the monitored period, and consequent introduction of trend variable there is used the capital “T” as a notation of the Student test.

F-test. There was also evaluated the value of the adjusted multiple determination coefficient \bar{R}^2 . Finally, the autocorrelation within the wine and beer consumption were tested too. Owing to the annual periodicity of used data and with respect to the consumption areas, there was only tested the autocorrelation of first order, see using DW-statistic, $\rho(1)$, LMF-test of the autocorrelation of the first order. Given the dynamic nature of the constructed models of the gross demand for wine and beer, due consideration was given to stationarity of the residues obtained after application of the regression models; see Arlt (1999) or Hušek (1999). Verification of the stationarity of time series of residues u_{wt} and u_{bt} was examined through the ADF tests of unit roots and their significance levels α . Selection of the most appropriate autoregression model for ADF-testing of the unit root, including setting the maximum length of the lag was done based on a combination of the results of T-tests, and the value of Modified Akaike Information Criterion (MAIC). With regard to these criteria of ADF-testing, the autoregressive models for both studied area of consumption was defined in the form: $\Delta u_t = (\alpha - 1) \times u_{t-1} + \beta \times \Delta u_{t-1}$, i.e. on the models without a constant, trend, and with the maximum delay of one year.

RESULTS AND DISCUSSION

Sensitivity analysis of the beer and wine consumption by the Czech households was researched through the coefficients of own and cross price elasticity and income elasticity. In order to the estimation of values of the coefficients of price and income elasticity there were constructed two mutually independent single-equation models of the gross demand with log-linear specification, see model (1) and (2). To capture the trends in

consumption of the wine and beer by the Czech households, the demand models (1) and (2) were added with a dynamic component, see a linear trend function: $a + b \times t$. Regression parameters of the dynamic models of the gross demand were determined based on the OLS method. Achieved values of parameters of the dynamic gross demand for wine – model (1) and the results of testing the statistical significance are contained in Tab. I.

Tab. I shows that the price of wine and beer prices and household incomes determine together rather strongly the wine consumption of the Czech households – see the value of multiple determination reaching almost 0.95, and its statistical significance greater than 99.99%. On the other hand, T-test of the c_w parameter showed that, in the wine consumption by the Czech households, the cross effect of the beer prices is not separately statistically significant (only 44.39%). Incomes effects in the wine consumption of the Czech households separately manifested statistically insignificant too (only 68.3%), see the results of T-test of the e_w parameter. Tab. I also shows that within the wine consumption by the Czech households there probably take the effect of some historical links that can be associated with, for example, patterns of wine consumption in the region. Wine consumption in the current year is quite strongly shaped by its consumption in the previous year, which primarily indicates the autocorrelation coefficient of the order 1 (44.42%) and the resulting Durbin-Watson statistics (1.1033). Also, the results of LMF-test show that the initial hypothesis regarding autocorrelation up to the first order cannot be rejected. According to the result of the ADF-test shown in Tab. I, it is apparent that the dynamic model of the gross demand for wine (1) generates a stationary time series of residues: $u_{wt} \sim I(0)$. The initial hypothesis of the presence of a unit root

I: *Dynamic model of wine consumption*

$\ln QW_t = [a_w + b_w \times t] + c_w \times \ln PCB_t + d_w \times \ln PWW_t + e_w \times \ln M_t + u_{wt}$				
parameter	value	Standard deviation	T-statistics	p(T)
a_w	2.93801	0.515222	5.702	< 0.0001
b_w	0.0151012	0.00476507	3.169	0.0053
c_w	-0.0428348	0.0714152	-0.5998	0.5561
d_w	-0.204802	0.0637888	-3.211	0.0048
e_w	0.0570211	0.0553971	1.029	0.3170
Coefficient of determination		Adjusted coefficient of determination		
$R^2 = 0.948619$		$\bar{R}^2 = 0.937201$		
F-statistics		Significance level of F-test		
$F(4; 18) = 83.08094$		$p(F) = 2.38 \times 10^{-11}$		
Autocorrelation coefficient of the 1 st order		Durbin-Watson statistics		
$\rho(1) = 0.444210$		$DW = 1.103343$		
Autocorrelation test up to 1 st order		Significance level of the -test		
$LMF = 5.76544$		$p[F(1; 7) > 5.76544] = 0.028062$		
ADF-test		$\alpha - 1 = -0.569594$		
$\Delta u_{wt} = (\alpha - 1) \times u_{wt-1} + \beta \times \Delta u_{wt-1}$		$\tau = -2.315; p(\tau) = 0.01989$		

Source: authors' calculations

II: *Dynamic model of beer consumption*

$\ln QB_t = [a_B + b_B \times t] + c_B \times \ln PWW_t + d_B \times \ln PCB_t + e_B \times \ln M_t + u_{Bt}$				
Parameter	Value	Standard deviation	T-statistics	p(T)
a_B	2.56652	0.671838	3.820	0.0013
b_B	-0.0222165	0.00621355	-3.575	0.0022
c_B	-0.0207912	0.0831792	-0.2500	0.8055
d_B	0.111174	0.0931238	1.194	0.2480
e_B	0.220209	0.0722366	3.048	0.0069
Coefficient of determination R²=0.565343		Adjusted coefficient of determination R² = 0.468753		
F-statistics F(4; 18) = 5.853001		Level of significance of the -test p(F) = 0.003371		
Coefficient of autocorrelation of the 1 st order p(1) = 0.280342		Durbin-Watson statistics DW = 1.406850		
Test of autocorrelation up to 1 st order LMF = 1.88991		Level of significance of the -test p[F(1; 7) > 1.88991] = 0.187063		
ADF-test: $\Delta u_{Bt} = (\alpha - 1) \times u_{Bt-1} + \beta \times \Delta u_{Bt-1}$		$\alpha - 1 = -0.542576$ $\tau = -2.25477; p(\tau) = 0.0233$		

Source: authors' calculation

in the time series of residues u_{Wt} can be rejected with the probability of 98%.

Based on the created log-linear dynamic model of the gross demand for wine, it can be stated that, in the years 1991–2013, 1% increase at the level of wine price have reduced its annual consumption per capita in the Czech Republic by 0.2048%. Consumer demand for the wine in gross terms, therefore, shows ordinary, but inelastic price reactions. Since the statistical significance of the point estimates of the remaining coefficients of demand elasticity was not sufficient (less than 90%), there were calculated their confidence intervals at 95% probability level. The value of the coefficient of cross price elasticity of the wine consumption then will be probably located in the range of -0.1929 to 0.1072. The scope of the defined confidence interval, or the possibility of the positive and negative estimates of this elasticity, however, does not give us the opportunity to clearly categorize the consumption interactions between wine and beer. The size of the coefficient of income elasticity for wine consumption is in the range of -0.05936 to 0.1734 with a 95% probability. Also in this case within the 95% confidence interval there appears an option of positive and negative estimates of the income elasticity of the given demand. Left (negative) limit of the confidence interval, however, does not reach too far from zero, so we can neglect this area of estimates, and consider the income-demand reactions in wine consumption by the Czech households as normal, nevertheless inelastic.

The parameters of the dynamic model of the gross demand for beer – model (2) and the results of testing the statistical significance are shown in Tab. II.

Tab. II shows that in the years 1991–2013 beer consumption of the Czech households in aggregate was not significantly shaped by the beer and wine price, and household income as it was in the case

of wine consumption. The coefficient of multiple determination in the case of the beer consumption was less than 57%. Its value, however, is relatively highly statistically significant (99.66%), see the results of F-test. T-test of the parameter showed that beer consumption of the Czech households in the monitored period the cross was not statistically significant affected by the wine price (with the probability of 80.55%). Also the effect of the price of beer to its consumption in the years 1991–2013 was not statistically significant. According to the T-test the parameter is statistically significant only with insufficient 75.20%. Unlike wine consumption, in the case of beer consumption there do not manifest the links to the previous period. Autocorrelation coefficient of order one reached lower value for beer consumption (28.03%) than it was for the wine consumption (44.42%). These findings suggest also achieving greater result of the Durbin-Watson statistics, which reached 1.4069. Unfortunately, at this level of the DW-statistics we can reject or accept the existence of the first order autocorrelation, because obtained value lays in grey zone of DW test. Therefore there was done the LMF-test. Based on its results we cannot reject the initial hypothesis of the absence of autocorrelation up to the order 1. In accordance with the ADF-test conducted, the results of which are shown at the bottom of Tab. II, it can be stated that the dynamic model of the gross demand for beer (2) generates a stationary time series of residues: $u_{Bt} \sim I(0)$. The null hypothesis of the presence of a unit root in the time series u_{Bt} was rejected with 97.67% probability.

Through the constructed log-linear dynamic model of the gross demand for beer, and the derived parameter, we can say that in the years 1991–2013 a one percent increase of a household income brought an increase in annual beer consumption

per capita by 0.2202%. Income-demand reactions in the given consumer area can therefore be classified as normal and inelastic. Because the point estimates of the cross and own price elasticity of beer consumption did not achieve satisfactory level of statistical significance, there were calculated (as in the case of wine) the intervals of their 95% confidence level. The value of the coefficient of cross price elasticity of beer consumption is then – with a 95% probability – located in the range of -0.1955 to 0.1540 . The scope of this confidence interval, though, gives a space for all possible of consumption interactions between beer and price of wine, i.e. for complementary or substitute relations, and for the situation of no consumption interactions. With 95% probability, the level of elasticity coefficient of own price of the beer consumption is from the interval of -0.08447 to 0.3068 . In this case, however, it is interesting to note

that centre of 95% confidence interval is deviated to the right of zero, and therefore the price-demand response do not have the ordinary character. This opposite direction of the price-consumption reactions can be explained through the quality effect, when a higher price of beer means a better quality of consumed beer. This explanation confirms the normal character of income-demand reactions within consumption of beer by the Czech households. Achieved results and findings are comparable with the conclusions from the foreign economic studies on the consumption of alcoholic beverages. In this regard, the sets of demand elasticity coefficients presented in the publications of Gallet (2007), Fogarty (2008) or Sousa (2014) are very useful, and provide a good comparative basis. These studies result in similar values of the elasticity coefficients as those calculated in this study.

CONCLUSION

The paper focused on consumer demand for wine and beer in the Czech Republic. Behaviour of the Czech households has been investigated through the consumption of these alcoholic beverages between 1991 and 2013. The objective of the analysis was to evaluate the elasticity of consumption of wine and beer to a change their prices and change in the level of household income. Through a pair of constructed symmetric models of dynamic demand function there were calculated coefficients of own and cross price elasticity and income elasticity. Particular emphasis in the analysis of this demand was placed on assessing the intensity of the cross price effects in the context of the consumption of wine and beer. Regression models of gross demand for wine and beer were constructed in log-linear form, enabling immediate estimates of the particular coefficients of examined elasticity and at the same time it was easily possible to assess their statistical significance.

On the basis of developed dynamic models of the gross demand for wine (1), and for beer (2) it was found that in the years 1991 to 2013 there was no statistically significant linkage between the consumption of wine and beer in neither direction. Through the model (1), there was further found that the sensitivity of wine consumption to changes in the household income in the period was not statistically significant. Wine consumption of the Czech households in the years 1991–2013 was statistically significantly formed only by its own price. According to the coefficient of own-price elasticity of wine, 1% increase of its prices would project into a decrease in annual consumption per capita by 0.2048%. The consumer demand for wine in gross terms, therefore, exhibits ordinary price reactions. However, the responses of demand to the price changes are inelastic. Autocorrelation coefficient of the first order (44.42%) indicated that the behaviour of Czech households in the wine consumption seems to have more permanent habits. Wine consumption in the current year is partly influenced by the consumption of wine in the previous year. With the help of the dynamic model of the gross demand for beer (2), it was found that beer consumption responded statistically significantly to the change in household income, in the years 1991 to 2013. In line with the estimate of income elasticity of the gross demand for beer it can be concluded that in the studied time period, one percent increase in household income brought a growth of the annual beer consumption per capita in the Czech Republic by 0.2202%. Income demand reactions in this consumption area can be classified as normal, but inelastic. Beer consumption in 1991–2013 showed no statistically significant sensitivity to changes in the price of beer. Within the consumption of beer there were not identified significant autoregression reactions of the first order, therefore this consumption is not influenced by consumption in the previous year.

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