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Demand for Beer in the Czech Republic: Understanding Long-Term On- and Off-Trade Price Elasticities

Stanislava GROSOVÁ, Michal MASÁR, Olga KUTNOHORSKÁ and Vladimír KUBEŠ*

Department of Economics and Management, Faculty of Chemical Engineering, University of Chemistry and Technology Prague, Prague, Czech Republic

**Corresponding author: grosovas@vscht.cz*

Abstract

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We provided estimates of price, cross-price, and income elasticities for on- and off-trade beer consumption using econometric models on time series data from 1994 to 2014. The empirical results indicate that the most important determinants of on-trade demand are the price of off-trade beer, the price of substitutes and past consumption, while the income elasticity was not found to be important. The most important determinants of off-trade beer demand were the price of on-trade beer and the price of substitutes.

Keywords: beer demand; price; cross-price and income-price elasticities; econometric model

According to many sources (Euromonitor Research 2014; Český svaz pivovarů a sladoven 2016) the Czech Republic is now the biggest per capita consumer of beer in the world. Over the period 1994–2008, Czech beer consumption was fairly stable; maximum (163 l/capita) was reached in 2004 and since that year it was slightly falling to 147.5 l/capita in 2014 (based on the whole population). During the same period, there has been changing dynamics in the proportion of on tap beer (on-trade) in total beer sales (Figure 1). From 1996 to 2004, there was a concomitant rise in on-trade beer sales, but since 2004 they have been falling steadily and there has been an evident rise of off-trade beer. In the Czech Republic, there is a long tradition of beer consumption in pubs and restaurants. According to Vinopal (2007), beer drinking is often a social affair, so some prefer to drink beer in pubs compared to solitary household consumption of bottled beer. This shift in beer consumption from restaurants and pubs to retail or households could have a significant impact on traditional Czech pubs. In order to determine an optimal course of the reaction, it is necessary to find the causes of these phenomena. There are some reasons for this shift, one of them are changing relative prices. The real price per litre of on-trade beer has risen by 23% from 1994 to 2014; the real price of off-trade beer has fallen by 12% in the same time period. The fall of off-trade prices is largely caused by strong competition and heavy discounts of beer products in supermarkets. The other causes may stem from income changes and food-related life-style changes.

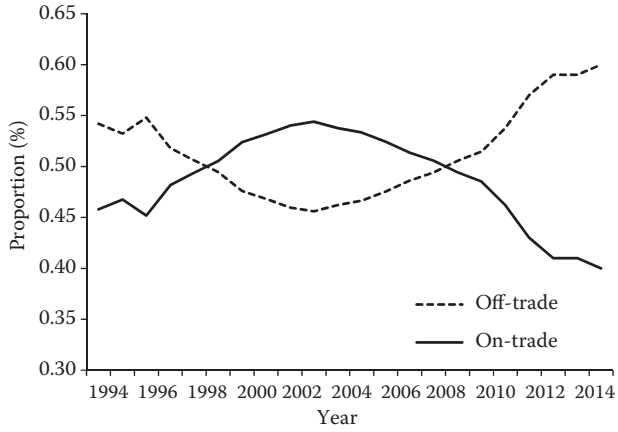

Figure 1. Proportion of on-and off-trade on total beer consumption (Source: Český svaz pivovarů a sladoven 2016)

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In this study we estimate price, cross-price, and income elasticities for Czech on- and off-trade beer consumption. Price elasticity (quantifies the influence of price change on consumption) and income elasticity (quantifies the influence of wages on demand) are defined in literature (Holman 2016). Own-price elasticities enable us to quantify the percentage change in demand for beer due to a 1% change in the price, and cross-price elasticities to quantify the percentage change in demand for on-trade beer due to a 1% change in the price of off-trade beer and vice versa.

There are many previous studies which concentrated on analysing alcohol drink price elasticities, often with the aim to influence alcohol consumption through formulating measures regarding the amount of taxes. Detailed reviews of results processed using the meta-analysis method and data describing the value of aforementioned coefficients for other types of alcoholic beverages can be found in Fogarty (2006, 2010), Gallet (2007), and Collis *et al.* (2010).

Beer cross-price elasticities, especially between off- and on-trade, have not been widely studied. Some previous studies (Ogwang & Cho 2009) suggested that off-trade purchasing and on-trade purchasing were typically substitutes, with some exceptions (Collis *et al*. 2010). Tomlinson and Branston (2014) study analysed the effect of beer price, household income and advertising costs on on- and off-trade beer consumption on data from 1982 to 2010; they found that price elasticity in on- and off-trade markets is elastic and customers are highly sensitive to changes in pricing.

Studies concerning the Czech beer price and income elasticity are scarce. Castiglione *et al*. (2011) studied the consumption of Czech beer, wine, and spirits on 2006–2008 monthly data and found out that the most important determinants of beer demand are price, income, and past consumption. Janda *et al*. (2010) analysed alcohol demand using the panel data and provided own-price, cross-price, and income elasticities of key alcoholic beverages.

In this article, we will estimate an empirical model in order to explain which reasons can explain the dynamics of changes in on- and off-trade consumption in the Czech Republic.

The key research questions are: (1) what are the own- and cross-price elasticities and income elasticity for on-trade and off-trade beer in the Czech Republic? (2) how do the estimates compare with some chosen estimates from the literature?

MATERIAL AND METHODS

Empirical model. Two econometric models were created to identify and to determine the main factors affecting the on- and off-trade beer consumption in the Czech Republic. Its construction is based mainly on the time series data. Like in other studies (Gallet 2007) which were confronted with similar problems, we use a log demand function. As stated by Alston *et al*. (2002), it is well known that the use of this method enables straightforward interpretation and is popular for demand studies focusing on a single commodity. According to Lee and Tremblay (1992) research, non-alcoholic beverages have increasingly been substituting alcoholic ones. Therefore we also use the price of mineral water in the model.

Adjustment to prices, income, on-trade and off-trade consumption. Annual aggregate time series for the years 1994 to 2014 were analysed. Český statistický úřad (1994–2016) provided data on inflation rate, base indices, consumer prices of selected products, per capita net household income, average annual beer prices by types and packaging, average annual prices of mineral water by type and packaging, per capita beer consumption, per capita mineral water consumption, total production volume of beer in the Czech Republic, and volume of beer imported to the Czech Republic.

Balach (2015) and Český svaz pivovarů a sladoven (2016) provided data on volume and ratio of distribution for domestic consumption, import and export, beer production volume and ratio based on packaging (bottled, cans, kegs, and tanks), beer production volume and ratio based on type (7–10, 11–12, 13, and more % of extractible wort, non-alcoholic).

Because the per capita beer consumption divided between on- and off-trade markets is not monitored by any organisation, a description of the input data modification follows. Total beer production volume reduced by export was considered as total domestic consumption, beer imports between 1994 and 2014 contributing in hundredths to the total consumption were omitted. In 1994 the import to production ratio was 0.005%; in 2014 it was 0.016%.

The on- and off-trade market volume ratio was determined as follows: canned and bottled beer represents off-trade, on-trade is represented by beer in kegs and tanks. The volume of bottled beer sold in on-trade markets and/or keg beer sold in off-trade markets represents only a marginal portion of the total volume and was therefore omitted. The effects

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of inflation were taken into account using the inflation rate in the given periods. Beer prices obtained from CZSO were recalculated using consumer price base indices to constant prices with the reference year 2005. The same source of data and recalculation method were also used for available data on per capita net household income. Considering the significant difference in average prices of lager and other beer types (according to extractible wort), the recalculation of beer prices applied in the model using beer prices and volumes is necessary. The prices for each year were calculated using weighted average, the weight being the ratio of produced beer categories. This method was used for both bottled and keg beer.

Statistical methods. The dependent (explained) variable in demand equations is beer consumption per capita. The prices of on- and off-trade beer and mineral water, income, and past beer consumption and mineral water consumption represent explanatory variables in equations.

An ordinary least squares (OLS) method was used to estimate regression model parameters. This method is most commonly used to estimate elasticity coefficients and parameters of econometric model. According to Gallet (2007), price and income elasticities are most commonly constructed from demand models that are estimated using OLS. The model verification included an assessment of the statistical significance of approximated parameters, equations, and the model as a whole. *i*-Test, *F*-test, and coefficients of determination were used to ascertain the significance of the models and parameters. Residual stationarity (Dickey-Fuller) test, residual autocorrelation (Durbin-Watson, Breusch-Godfrey) test, explanatory variable multicollinearity test, model heteroscedasticity (Breusch-Pagan) test, and goodness-of-fit (Jarque-Bera) test were carried out as a part of the verification of econometric model assumptions (Hušek 2007).

Model specification and testing. The models assume that on-trade and off-trade beer is sold on different markets and therefore can be considered as substitute products. The model also includes past consumption, which is always included as an explanatory variable for addictive goods. Addictive goods include alcohol, tobacco products, and drugs (Yu & Abler 2010). The Authors state that addiction, taste enhancement, and tolerance are typical traits of addictive goods. Addiction has the effect on the preference of given goods compared to others; taste enhancement means that present consumption influences future consumption. Delayed consumption is also used in non-addictive goods models, e.g. Brown (1952). Delayed variable Q_{t-1}^{on}, which can significantly affect present beer consumption in restaurants and pubs, was therefore included in the on-trade model. The regression model is a standard demand function, according to McGuiness (1980) and Tomlinson and branston (2014) and is denoted in log form. A description of variables is provided in Table 1.

For an on-trade model:

$$\mathrm{Ln}Q_t^{on} = \beta_0 + \beta_1 \times \mathrm{Ln}Y_t + \beta_2 \times \mathrm{Ln}\,P_t^{on} + \beta_3 \times \mathrm{Ln}\,P_t^{off} + \beta_4 \times \mathrm{Ln}\,P_t^{miner} + \beta_{\check{r}} \times \mathrm{Ln}\,Q_{t-1}^{on} + u \quad (1)$$

For an off-trade model:

$$\mathrm{Ln}Q_t^{off} = \beta_0 + \beta_{11} \times \mathrm{Ln}Y_t + \beta_{12} \times \mathrm{Ln}\,P_t^{on} + \beta_{13} \times \mathrm{Ln}\,P_t^{off} + \beta_{14} \times \mathrm{Ln}\,P_t^{miner}\,1 + u \quad (2)$$

During the calculation, it was necessary to deal with the multicollinearity of explanatory variables. This was solved by introducing the first or second differences to variables price of mineral water and

Table 1. Variables used in on- and off-trade consumption models

Variable	Variable name in model	Unit of measure
Q_t^{on}	average per capita beer consumption on-trade	l/year/capita
Q_{t-1}^{on}	average per capita beer consumption on-trade in previous year	l/year/capita
Q_t^{off}	average per capita beer consumption off-trade	l/year/capita
Y_t	real disposable household income 'income'	CZK/year/capita
P_t^{on}	on-trade market consumer beer price 'priceON'	CZK/0.5 l
P_t^{off}	off-trade market consumer beer price 'priceOFF'	CZK/0.5 l
P_t^{miner}	mineral water consumer price 'priceMINER'	CZK/0.33 l
Q_t^{miner}	carbonated mineral water consumption	l/year/capita
u	random component	

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income. This approach by Granger and Newbold (1974) guards against a possibility that the smooth movement of economic variables typically observed over time is responsible for a spurious relationship between variables which were estimated by the econometric model in this study. Thusly modified variables were implemented into the on-trade model. The model parameter estimates are shown in Table 2.

Similar variables are used in the off-trade model. The off-trade model was more complicated compared to the on-trade one because in the process of the model identification it was often impossible to meet the classical regression model prerequisites for the random component (Wooldridge 2013). The selected model included variables off-trade market beer consumption, available household income, on-trade market beer price, off-trade market beer price, and mineral water consumption. Due to the steadily rise of off-trade beer consumption from 2004 and R-squared characteristics of the previous off-trade model, a second model using data from 2004 to 2014, which could better explain off-trade beer consumption, is introduced.

RESULTS

The models appear to perform well with relatively high explanatory power, judged on the basis of adjusted coefficients of determination (Tables 2 and 3). Statistical tests for residual autocorrelation, stationarity, homoscedasticity, and residual normality appear to show that all three models are well defined.

On-trade model. It can be stated that the logarithm of beer consumption volume in the previous period and the logarithm of off-trade price are highly statistically significant parameters. A 1% rise in the off-trade market average annual beer price results in a 0.493% (*ceteris paribus*) rise of on-trade annual consumption per capita. Off-trade beer can therefore be considered as a substitute of on-trade beer. It is obvious that the rise of beer prices on off-trade markets leads to increasing consumption volumes on on-trade markets. Delayed consumption affects present consumption in restaurants and pubs. It is possible to assume that the 1% rise in per capita beer consumption in the previous year would induce a 0.945% (*ceteris paribus*) rise in the current year beer consumption. Thus, the previous beer consumption volume affects the current beer consumption volume in the Czech Republic. Another statistically significant parameter is the price in on-trade, which is, in concordance with expectations, of negative value. It is possible to assume that the 1% rise in on-trade average annual price results in a 0.13% fall of on-trade annual consumption per capita. The last important variable is mineral water price. Based on its negative value, it can be assumed that natural mineral water is a complementary product to on- and off-trade beer.

Income elasticity is very low and it is not significant in the on-trade model. Especially from the economic point of view, it is difficult to accept that the effect of income is not very different from zero because a number of previous studies concluded that the income is a major influence on alcohol consumption. There

Table 2. On-trade beer consumption model approximated parameters 1995–2014

Variable	1995–2014
Const.	–0.54520**
ln_'priceON'	–0.13432**
ln_'priceOFF'	0.49345***
d_d_ln_income	0.08297
d_ln_'priceMINER'	–0.02687**
ln_consumptionON_–1	0.94473***
R^2	0.959
R^2_{adj}	0.943
F statistics	308.6973
Log likelihood	43.27413
Akaike	–74.54826
Durbin-Watson	–2.091242

**; ***significance at the 5 and 1% levels

Table 3. Off-trade beer consumption model approximated parameters 1995–2014 and 2004–2014

Variable	Off-trade	
	1995–2014	2004–2014
Const.	4.73841***	5.47096***
l_'priceON'	0.48586*	0.98626***
l_'priceOFF'	–0.34980	–0.29900*
d_l_income	–0.73734*	–0.89793
l_consumptionMINER	–0.23020***	–0.78168***
R^2	0.683122	0.807075
R^2_{adj}	0.569952	0.678458
F statistics	54.074	67.082
Log likelihood	40.02286	24.92504
Akaike	–68.04571	–39.85008
Durbin-Watson	1.079535	1.773737

*; **; ***significance at the 10%, 5%, 1% levels

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is some support from earlier research. Ogwang and Cho (2009) reported that income emerged as a not important determinant of the consumption of beer. Similarly, Johnson and Oksanen (1974) found that the estimated income coefficient was insignificant in the analysis of beer and wine consumption.

Off-trade models. The highly statistically significant parameter in the 1995–2014 off-trade model is the mineral water consumption logarithm. From the coefficient value –0.23, it can be assumed that mineral water is a complementary product to bottled beer in this model. From this interpretation it is obvious that an increase in mineral water consumption leads to a decrease in beer consumption on off-trade markets. Income is another influential but less statistically significant parameter in this model. Similarly to the on-trade model, judging from the model results it can be assumed that a rise in income leads to a decrease in off-trade beer consumption.

On-trade price elasticity has a positive value according to the expectations and is highly statistically significant in the 2004–2014 model. It can be stated that a 1% rise of on-trade beer price results in a 0.986% (*ceteris paribus*) increase in off-trade beer consumption and, therefore, on- and off-trade beers are close substitutes.

From the fact that the own-price elasticity coefficient in the shorter time series model is statistically significant and its value is lower compared to the longer time series model, it can be assumed that the demand is not elastic and the increase in off-trade beer consumption is caused dominantly by high prices of on-trade beer.

CONCLUSION

Overall, the results can be summed up in the following way. Decreasing on-trade beer consumption is affected by decreasing beer prices on off-trade markets characterised by strong competition between bottled beer producers. A rise in the on-trade beer price is also the reason for a decrease in the consumption of that beer.

The estimates of cross-price elasticity between on- and off-trade beer as being 0.49 and 0.98 imply that on- and off-trade beers are substitutes. This finding is consistent with the research of Tomlinson and Branston (2014), who also found out a substitution between on- and off-trades. The comparison of own-price elasticity with the aforementioned study reveals that Czech beer drinkers are not so price sensitive as UK beer drinkers.

According to the Euromonitor Research (2014), average beer price elasticity on off-trade markets is –0.5. Although there is no direct comparison with the results in this study due to the formulation of explanatory variables, in Czech Republic price elasticity terms, this does seem to fit the pattern where beer, the most popular alcoholic beverage, is inelastic.

This article can be extended in two ways. Future research may explore beer income elasticity to a larger extent because there are differences from other studies. Further, the influence of other alcoholic and non-alcoholic beverages on beer consumption should be investigated.

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