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THE V4 COUNTRIES BEER MARKET DEVELOPMENT

Martin Richter*, **Eva Richterová, Iveta Zentková**

Slovak University of Agriculture in Nitra, Slovak Republic

The aim of the paper is to find out the relationship between beer productions in separate V4 countries. Logarithmic regression analyses with corrected heteroscedasticity and autocorrelation is used to observe the relationship between beer production as dependent variable and independent variables beer consumption, barley and hops yield, imported and exported quantity. All estimated logarithmic regression models are statistically highly significant. Variables without statistical significance are not interpreted. All interpreted variables are inelastic. Except of Czech Republic beer consumption is significant variable in relation to beer production what can suggest export orientation of Czech breweries. Exported beer quantity is significant variable in given model. In Slovakia barley yield is statistically significant but negatively correlated to beer production. In other countries barley and hops yields are not statistically significant. This may mean that these crops are not directly used in domestic beer production. Crops are exported in order to obtain higher added value from side of primary producers. Based on that, beer is mostly produced from intermediate products or imported from other countries.

Keywords: beer; beer production; beer consumption; regression analyses; elasticity

Introduction

The tradition in beer production and consumption in European countries is deeply rooted. Except of the traditional beer drinking countries like Germany, Austria or Ireland there is a group of post-communist countries in the middle of Europe with traditional beer production. The V4 counties Poland, Hungary, Slovakia and the global leader in the per capita beer consumption, Czech Republic.

Beer is one of the most popular alcoholic beverages in the world. Its worldwide production reached the peak (1.97 billion hl) in 2013 (Statista, 2018).

Before the 1990s Bulgaria, ex-Czechoslovakia and Hungary were the only countries from the CEE region that were members of the European Brewing Union. They had well-established brewing traditions with modern technology and production know-how (Larimo et al., 2006).

The strongest growth in beer consumption is in middle and low income countries which experience growth, such as China, Russia, Poland and India. In contrast, in many traditional "beer-drinking nations", such as Belgium, the UK, Germany and the Czech Republic, there has been a reduction in beer consumption per capita and beer lost importance in favor of other alcoholic drinks. The opposite is true in "wine-drinking (e. g. Spain and Italy) and "spirit-drinking" (e.g. China and Russia) countries, leading to a convergence of alcohol consumption patterns across countries.

During history, not just the geographic spread of beer production and consumption changed, but also the technologies used and the industrial organization of the beer industry (Poelmans and Swinnen, 2011).

The EU is the second largest beer producer in the world, after China. There are over 6,500 active breweries, which produced around 383 million hectoliters of beer in 2014.

Domestic consumption has declined over several years, affected by wider macroeconomic trends, but is increasing in 2014 in line with the early stages of economic recovery. Total consumer spending was over € 110 billion in the EU in 2014. In part this reflects companies innovating with new craft and specialty offerings appealing to changing consumer tastes (Brewers of Europe, 2016).

Craft brewers and their customers have transformed global beer markets over the past two decades, ending a century of consolidation that resulted in the domination of a few global multinationals and the homogenization of beer. They started small and isolated but ultimately transformed a global industry (Garavaglia and Swinnen, 2017).

Material and methods

Eurostat data of individual V4 countries population are used. The beer, barley and hops data comes from The Brewers of Europe and FAOSTAT. All the absolute data are recalculated to relative data. The FAOSTAT barley and hops yield are converted from hectograms on hectare to tones on hectare. The conversion is conducted using the coefficient 9,071.8474 hectograms is equal to one tone. Imported and exported quantity is also converted from tones to liters per capita. The coefficient; 1 tone of beer equals to 990,1 liters of beer is used.

Under regression we understand study of the relationship between two or more variables using statistical model, which is characterizing the dependency between the selected variables. Using regression model expresses the quantitative influence of separate explanatory (independent) variables on the explained (dependent) variable. The linear regression model explains the relationship between dependent variable Y and k number of independent variables X_j ($j = 1, 2..., k$). It has a general form:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik} + e_i$$

The absolute member – coefficient β_0 is called intercept. It is interpreted as a conditional mean value variable Y assuming that all explanatory variables take the value zero.

Coefficients X_j ($j = 1, 2..., k$) are called regression coefficients. Regression coefficient β_j shows how the mean value of the dependent variable Y changes, if the independent variable X_j changes by one unit and the other variables stays unchanged (Šoltéz, 2008).

All analyses are conducted using regression model. All the data are logarithm. Multicollinearity is not proved in any model. Heteroscedasticity and autocorrelation problems are removed using heteroscedasticity autocorrelated consistent (HAC). Due to the use of logarithmical data in regression models, all the regression coefficients represent elasticities.

Results and discussion

The V4 countries beer production decreased between 2003 and 2016 only by 2%. Deep production decrease in Slovakia and Hungary, caused by beer consumption decrease, was covered by production increase in Poland and Czech Republic.

Figure 1 shows the trend of annual beer production in liters per capita in V4 countries during period 2003–2016. The highest beer production is in Czech Republic. The lowest beer production we observed in Slovakia. As Figure 1 demonstrates, beer production in Slovakia and Hungary is declining during years 2003–2016. On other hand beer production in Czech Republic and Poland is growing. Trend of production is almost copying the trend of consumption, only exception is Czech Republic, where despite of that beer consumption declines and beer production grows. Czech Republic is one of the largest European exporters with popular beer brands such as Pilsner Urquell, Budweiser etc. Besides consumption, there are also several other factors, which can affect the amount of beer production such as barley yield, hops yield, import and export of beer. In next part the influence of those five chosen beer production factors in V4 countries is analyzed.

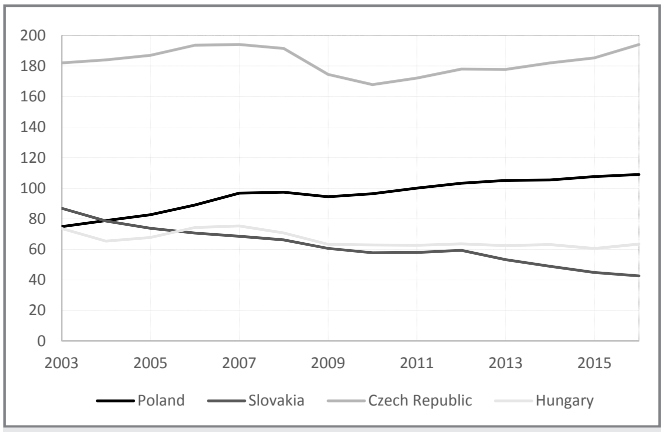

Figure 1 V4 annual beer production in liters per capita
Source: Brewers of Europe

All the regression analyses data are logarithm. The dependent variable y represents annual beer production in liter per capita. The selected independent time series variables are x_1 annual beer consumption in liter per capita, x_2 barley yield in tons on hectare, x_3 hops yield in tons on hectare, x_4 import in liter per capita and x_5 export in liter per capita. Models for all countries are statistically highly significant.

Table 1 Model Poland: OLS, using observations 2003–2016 ($T = 14$)
Dependent variable: l_Annual per capita beer production
HAC standard errors, bandwidth 1 (Bartlett kernel)

	Coefficient	Std. Error	*t*-ratio	*p*-value	
Const.	1.24081	0.382993	3.240	0.0119	**
l_Anual per capita beerconsumpti	0.724264	0.0876660	8.262	<0.0001	***
l_Barleyyieldintha	-0.0127559	0.0399440	-0.3193	0.7576	
l_Hopsyieldintha	0.0418458	0.0397482	1.053	0.3232	
l_Import in liter per capita	0.0006509	0.00943941	0.06896	0.9467	
l_Export in liter per capita	0.0478551	0.00920769	5.197	0.0008	***

Mean dependent var	4.555553	S. D. dependent var	0.117944
Sum squared resid	0.002526	S. E. of regression	0.017771
R-squared	0.986030	Adjusted R-squared	0.977299
F (5. 8)	355.0510	*P*-value (*F*)	3.64e-09
Log-likelihood	40.47504	Akaike criterion	-68.95008
Schwarz criterion	-65.11574	Hannan-Quinn	-69.30502
rho	0.138496	Durbin-Watson	1.572187

Source: own calculations

Estimated regression function:

$$y = 1.2408 + 0.7243x_1 - 0.0128x_2 + 0.0418x_3 + 0.0007x_4 + 0.0479x_5$$
$$\mathbf{(0.0119)}\ \mathbf{(<0.0001)}\ (0.7576)\ \ (0.3232)\ \ (0.9467)\ \ \mathbf{(0.0008)}$$

There are two factors in this model, which influence on production is significant (P value <0.05) – consumption of beer and export. Model explains more than 98% of dependent variables changes. The most significant coefficient is the annual beer consumption per capita. Based on the coefficient, we can state, that 1% increase in polish beer consumption can lead to an inelastic production increase by 0.72% on average. The second significant coefficient for export indicates, that 1% export increase can cause increase in beer production by 0.05% on average. Beer export is for polish beer producers not as important as consumption. Polish beer consumers were the most important factor for beer production in Poland. which is the only one V4 country with increasing per capita beer consumption. Polish beer consumption increased between 2003–2016 by 32%.

Table 2 Model Slovakia: OLS, using observations 2003–2016 ($T = 14$)
Dependent variable: l_Annualpercapitabeerproducti
HAC standard errors, bandwidth 1 (Bartlett kernel)

	Coefficient	Std. Error	*t*-ratio	*p*-value	
Const.	1.41680	1.55843	0.9091	0.3899	
l_Anual per capita beerconsumpti	0.871119	0.312450	2.788	0.0236	**
l_Barleyyieldintha	-0.307169	0.0655615	-4.685	0.0016	***
l_Hopsyieldintha	-0.006544	0.0766222	-0.08541	0.9340	
l_Import in liter per capita	-0.232975	0.0519680	-4.483	0.0020	***

l_Export in liter per capita	-0.0254995	0.0132553	-1.924	0.0906	*

Mean dependent var	4.109306	S.D. dependent var	0.208120
Sum squared resid	0.023715	S.E. of regression	0.054447
R-squared	0.957883	Adjusted R-squared	0.931560
F(5. 8)	281.1422	*P*-value (*F*)	9.19e-09
Log-likelihood	24.79968	Akaike criterion	-37.59936
Schwarz criterion	-33.76501	Hannan-Quinn	-37.95430
rho	0.042947	Durbin-Watson	1.689318

Source: own calculations

Regression function was conducted in form:

$$y = 1.4168 + 0.8711x_1 - 0.3072x_2 - 0.0065x_3 - 0.2330x_4 - 0.0255x_5$$
$$(0.3899)\quad \mathbf{(0.0236)}\quad \mathbf{(0.0016)}\quad (0.9340)\quad \mathbf{(0.0020)}\quad (0.0906)$$

We revealed two coefficients which are highly significant (barley yield. import) and one significant (consumption). Model explains 95.79% of the explained variable changes. If the Slovak consumers beer consumption increase by 1%, we can await an increase in its production by 0.87% on average. All the following coefficients are negative correlated to the beer production. 1% increase in barley yield can cause beer production decrease by 0.30% on average what can suggest that barley is exported and Slovak beer production is mostly based on intermediate products. A great part of beer consumption in Slovak Republic is covered by imported beer. Beer import increase by 1% can lead to decrease in Slovak beer production by 0.23% on average.

Table 3 Model Czech Republic: OLS, using observations 2003–2016 ($T = 14$)
Dependent variable: l_Annualpercapitabeerproducti
HAC standard errors, bandwidth 1 (Bartlett kernel)

	Coefficient	Std. Error	*t*-ratio	*p*-value	
Const	4.56033	0.896446	5.087	0.0009	***
l_Anual per capita beerconsumpti	0.0581811	0.167208	0.3480	0.7369	
l_Barleyyieldintha	-0.0643668	0.0275506	-2.336	0.0477	**
l_Hopsyieldintha	0.0361525	0.0179163	2.018	0.0783	*
l_Import in liter per capita	-0.0958954	0.0152108	-6.304	0.0002	***
l_Export in liter per capita	0.159780	0.0164649	9.704	<0.0001	***

Mean dependent var	5.208934	S.D. dependent var	0.046452
Sum squared resid	0.003015	S.E. of regression	0.019412
R-squared	0.892529	Adjusted R-squared	0.825360
F (5. 8)	50.27589	P-value(*F*)	7.87e-06
Log-likelihood	39.23807	Akaike criterion	-66.47614
Schwarz criterion	-62.64180	Hannan-Quinn	-66.83108
rho	-0.162806	Durbin-Watson	2.229718

Source: own calculations

Estimated regression function in form:

$$y = 4.5603 + 0.0581x_1 - 0.0644x_2 + 0.0362x_3 - 0.0959x_4 + 0.1598x_5$$
$$\mathbf{(0.0009)}\quad (0.7369)\quad \mathbf{(0.0477)}\quad (0.0783)\quad \mathbf{(0.0002)}\quad \mathbf{(<0.0001)}$$

V4 countries are beer drinkers. All, Poland, Czech, Slovakia and Hungary are in the top 20 beer drinking nations, masterfully led by Czech Republic with annual per capita beer consumption of about 143 liters. Nevertheless, Czech Republic beer consumption does not seem to be important for quantity produced. Annual per capita beer consumption for this country is not statistically significant. The highly statistically significant coefficient in model for Czech Republic is annual exported quantity in liters per capita. The coefficient reached the value 0.16. An increase in exported quantity by 1% can lead to an inelastic increase in in beer production by 0.16% on average. From the research above, Czech beer production may be highly pro-export oriented. Czech beer export is, except of years 20072009, increasing and between 2003 and 2016 it increased by 242%. On the opposite side an increase of imported quantity by 1% is able to decrease produced beer quantity by only 0.09% on average what confirms our previous statement. Similar to Slovakia barley yield coefficient has negative correlation. This model clarifies 89% of Czech beer production variations.

Table 4 Model Hungary: OLS, using observations 2003–2016 ($T = 14$)
Dependent variable: l_Annualpercapitabeerproducti
HAC standard errors, bandwidth 1 (Bartlett kernel)

	Coefficient	Std. Error	*t*-ratio	*p*-value	
Const	2.19487	0.907532	2.419	0.0419	**
l_Anual per capita beerconsumpti	0.560811	0.186840	3.002	0.0170	**
l_Barleyyieldintha	0.0321369	0.0927041	0.3467	0.7378	
l_Hopsyieldintha	-0.0134009	0.00770375	-1.740	0.1201	
l_Import in liter per capita	-0.193901	0.113128	-1.714	0.1249	
l_Export in liter per capita	0.0397788	0.0184324	2.158	0.0630	*

Mean dependent var	4.192372	S.D. dependent var	0.074210
Sum squared resid	0.004810	S.E. of regression	0.024521
R-squared	0.932810	Adjusted R-squared	0.890816
F (5. 8)	283.2001	P-value (*F*)	8.93e-09
Log-likelihood	35.96715	Akaike criterion	-59.93431
Schwarz criterion	-56.09996	Hannan-Quinn	-60.28924
rho	0.052650	Durbin-Watson	1.888228

Source: own calculations

Regression function was estimated in form:

$$y = 2.1949 + 0.5608x_1 + 0.0321x_2 - 0.0134x_3 - 0.1939x_4 + 0.0398x_5$$
$$\mathbf{(0.0419)}\ \mathbf{(0.0170)}\quad (0.7379)\quad (0.1201)\quad (0.1249)\quad (0.0630)$$

In Hungarian model only, annual beer consumption coefficient is significant. Beer consumption increase by 1% can cause an inelastic increase in beer production by 0.56% on average. Model explains 93% of beer production changes in Hungary. As we already stated relative beer consumption and production curves almost copy each other and other selected factors does not seem to be relevant in this model.

Conclusions

The V4 countries beer production decreased between 2003 and 2016 only by 2%. Deep production decrease in Slovakia and Hungary, caused by beer consumption decrease, is covered by production increase in Poland and Czech Republic.

Beer production increase in Poland is motivated by strong beer consumption rise. Based on the calculated coefficient, 1% increase in polish beer consumption can lead to an inelastic production increase by 0.72% on average. Polish beer export increase by 1% can cause increase in beer production by only 0.05% on average. Most of polish beer production is consumed by domestic consumers.

Slovak beer production decreased faster than consumption. A great part of beer consumption in Slovak Republic is covered by imported beer. Beer import coefficient is statistically highly significant. An increase in imported quantity by 1% can lead to decrease in Slovak beer production by 0.23% on average. Beer consumption increase in Slovakia by 1%, can cause an increase in its production by 0.87% on average.

Except of Czech Republic all the beer consumption coefficients are statistically significant. However, the export coefficient for Czech Republic is statistically highly significant. An increase in exported quantity by 1% can lead to an inelastic increase in beer production by 0.16% on average and Czech beer export increased to almost double during the observed period.

In Hungary, beer consumption increase by 1% can cause an inelastic increase in beer production by 0.56% on average. Beer consumption and production curves almost copy each other and other selected factors does not seems to be relevant in this model.

In Slovakia barley yield is statistically significant but negatively correlated to beer production. In other countries barley and hops yields are not statistically significant. This may mean that these crops are not directly used in domestic beer production. Crops are exported in order to obtain higher added value from side of primary producers. Based on that, beer is mostly produced from intermediate products or imported from other countries.

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Contact address

Martin Richter, Slovak University of Agriculture, Faculty of Economics and Management, Department of Economics, Tr. Andreja Hlinku 2, 949 76 Nitra, Slovak Republic, phone: +421 37 641 45 93, e-mail: martin.richter@uniag.sk