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ANALYSIS OF THE SLOVAK WINE EXPORTS BY GRAVITY MODEL

ANALÝZA SLOVENSKÉHO EXPORTU VÍNA VYUŽITÍM GRAVITAČNÉHO MODELU

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The focus of the paper is to determine the tendency of development of Slovak wine international trade. The objective of the article is to identify barriers and positive stimulants of wine exports using the gravity model. On the one hand, the basic determinants of gravity model as GDP per capita, number of inhabitants in the import countries and the distance between Slovakia and its business partners are considered as the potential determinants for the Slovak wine export. On the other hand, there are other factors used that come from papers with similar topics and those are production of the domestic country, membership in international and trade organizations, common characteristics of the domestic country and its business partners. Based on the results of this research, variability of dependent variable can be better explained by model with cross-cutting nature than by the panel model. Significant variables behave according to the general presumptions. Membership in the EU, the OECD and the WTO were determined by the model as the factors without significant influence on Slovak wine export. Common characteristics, however, appeared to have positive impact on mutual foreign trade. Furthermore, it was found out that the Slovak wine is seen as an inferior good by the consumers.

Key words: foreign trade, determinants of export, wine, gravity model

Slovak wine sector is in a specific position. It is characterized by the long-term shortage of own wine production in the market what has since 2000 created the option for flow of the foreign wines which represent 50 % of the market in recent years. Slovak consumers predominantly prefer the table wines; however, the domestic production is mostly oriented on the quality wines. This situation supports the export of the quality wines as there is no demand on the domestic market.

The intensity the country is linked to the international trade, determines the rate of economic openness. The open economies can consequently use the advantage of participating in the international economic space.

To place the production in the best possible way is a crucial point for the producers and it contains also the decision about placing the good in domestic or foreign market. Decision about using the foreign market must be accompanied with collecting of information about this space. Who the potential consumer is, what his preferences are and if the consuming capacity of this space is able to accept new volume of goods are the aspects which have to be known before entering the new market. If the decision is taken on the national level it would be very useful to know, what are the main factors stimulating the international trade.

These questions can be answered by using the gravity model of international trade. The model can be used not just to simulate bilateral relationships but also to find a solution: analysis of tourism competitiveness Archibald – LaCorbiniere (2008), the Internationalization of Inventive Activity, Picci (2008) simulating of transport (Kortschak, 2004).

The majority of gravity models of international trade are dealing with simulating of trade from the national perspective but not as many studies focus on international trade of particular good. Those models which contain wine as an object of the analysis come from the authors, who address foreign wine trade of countries with massive production for instance Carlucci et al. (2008) studied new opportunities for Italian exports of table and quality wines, Konig and Schulze (2006) analyzed federal export of German wines, Fleming, Mueller and Thiemann (2009) studied impact of the ICT technology on wine trade.

Materials and methods

Characteristics of the gravity model of foreign trade

Gravity model assesses the trading allocation of goods transmitted to the destination country. We take as a base model (1) developed by the authors Carlucci et al. (2008), who modeled the foreign trade of the Italian table and quality wines:

$$\ln ExpQw_{jt} = \alpha_0 + \alpha \ln QwProd_{it} + \beta \ln PcGDP_{jt} + \gamma \ln Pop_{jt} + \delta \ln Dist_j + \lambda_k Group_k + \varepsilon_{jt} \quad (1)$$

where:

- $ExpQw_{jt}$ – the value of home (Italian) export of wine to the country j in year t in eur (instant prizes)
- α_0 a κ – constants
- $QwProd_t$ – production of home quallity wines, year *t*, in hl
- $PcGDP_{jt}$ – GDP per inhabitant in the country of import (*j*), year *t*, in USD (instant prizes)
- Pop_{jt} – the population of the country '*j*' year *t*, in mil. of inhabitants
- $Dist_j$ – distance of the countries (capital cities) (*j*) from exporting country *i*, in km
- $Group_k$ – dummy variable which takes value 1 if state *j* belongs to group κ

Cross-sectional analysis

According to König and Schulze (2008) study, we will analyze foreign trade with the wine using the cross-sectional and longitudinal data.

The cross-sectional analysis estimates several competing models and assess their suitability. Cross-sectional data are

obtained for 19 countries, which imported Slovak wines in 2009. The relationship among the Slovak wine exports as the dependent variable and independent variables is characterized by equation (2):

$$\ln ExpW_j = \gamma_0 + \beta_1 \ln GDP_j + \beta_2 \ln Pop_j + \beta_3 \ln Dist_j + \beta_4 \ln EU_j + \beta_5 \ln OECD_j + \beta_6 \ln WTO_j + \beta_7 MENA_j + \beta_8 HRAN_j + \beta_9 \ln JAZ_j + \beta_{10} ÚHist_j + \beta_{11} \ln RFAC_j + \beta_{12} \ln SIM_j + u_j \quad (2)$$

where:

$ExpW_j$ – the value of Slovak export of wine to the country *j*
γ_0 – constant
GDP_j – GDP per inhabitant of the country *j*
Pop_j – the population of the country *j*
$Dist_j$ – distance of the countries (capital cities) from exporting country *j*
EU_i, *OECDi, WTOi* – dummy variables that take value 1 if the country *j* belongs to these organizations
$MENA_j$ – dummy variable expressing the common currency of the country *i* and *j*
JAZ_j – common language / common base language country *i* and *j*
$HRAN_j$ – dummy variable which takes value 1 if state *j* has a state border with the country *i*
$ÚHist_j$ – dummy variable which takes value 1 if state *j* has territorial history of the country of export *i*
$RFAC_j$ – an absolute difference of logarithms of relative factor „endowments"
SIM_j – similarity index of economic size – the index of similarity of the economy
β – the sensitivity change of the dependent variable (export of SR) to changes in independent variables
u_j – latent variable

In cross-sectional model we do not count with the variable wine production of exporting country „$Prod_i$" because average annual value of this variable is constant within one year. This means that we can exclude the effect of a change of this value to changes in the dependent variable – wine exports to the countries '*j*'.

Panel analysis

To examine the bilateral trade of SR with the wine we use pooled regression model. Pooled regression is the estimation method, at which the time cross-sectional component of panel data is not differed. Model is pooled with the several restrictions. The premise is that the coefficients $\alpha, \beta, \gamma, \delta, \zeta, \eta$ are identical for all *j* and *t*. Time period for which we are examining the dependent variable is the period 2004 – 2010. Model (3), whereby we estimate the allocation of Slovak export of wines abroad, can be define as

$$\ln ExpW_{jt} = \alpha_0 + \alpha \ln QwProd_{it} + \beta \ln PcGDP_{jt} + \gamma \ln Popj_t + \delta \ln Dist_j + \zeta \ln RFAC_{jt} + \eta \ln SIM_{jt} + \lambda_1 EU_{jt} + \lambda_2 OECD_{jt} + \lambda_3 WTO_{jt} + \lambda_4 MENA_{jt} + \lambda_5 ÚHis_{tj} + \lambda_6 HRAN_j + \lambda_7 JAZ_j + \varepsilon_{jt} \quad (3)$$

where:

$ExpW_{jt}$ – the value of Slovak export of wine to the country *j*
α_0 – constant
$PcGDP_{jt}$ – GDP per inhabitant of the country *j*, year *t*, in USD (instant prizes)
Pop_{jt} – the population of the country *j*, year *t*, in mil. inhabitants
$Dist_j$ – distance of the countries (capital cities) from exporting country j
RFAC – an absolute difference of logarithms of relative factor „endowments"
SIM – similarity index of economic size – the index of similarity of the economy
EU, OECD, WTO – dummy variables that take value 1 if the country *j* belongs to these organizations
MENA – dummy variable expressing the common currency of the country *i* and *j*
ÚHist – dummy variable which takes value 1 if state *j* has territorial history of the country of export *i*
HRAN – dummy variable which takes value 1 if state *j* has a state border with the country *i*
JAZ – common language / common base language country *i* and *j*
$\alpha - \eta$; $\lambda_1 - \lambda_7$ – the sensitivity change of the dependent variable to changes in independent variables

The gravity model is a logarithmic model. Dependent variable, export of Slovak wines, however, includes a zero value of the variable. These are the cases where country i (SR) with the destination country j was not involved in trade. Logarithm of zero is not mathematically defined. According to Silva and Tenreyro (2005) currently are being used several methods for solving this problem. Most of the works abstract from zero values of the dependent variable and in the model leave only non-zero value. Some authors estimate the model using observations with the value of $T_{ij} + 1$(T_{ij} – value of the dependent variable in time), or they use the Tobit estimator.

In our work we use methods of data abstraction from zero dependent variable – Method 1 and also $T_{ij} + 1$ values of the dependent variable – Method 2.

Data about the number of inhabitants of the examined countries were received from the databases of the OECD; we recalculated the distance from the countries based on the air distance of their capital cities. The source of data about gross domestic product of countries is the database of UN. Slovak wine production in the reporting period is recorded by Eurostat database. The data about exports of the Slovak wine to the reporting countries was drawn from a database INTRASTAT SR.

We determine the appropriateness of the model based on value adjusted regression coefficients. The model is suitable to describe the relationship between the dependent variable and independent variables, when adjusted regression coefficient is high enough and the majority of variables included in the model is statistically significant (*P*-value).

Results and discussion

Specification of variables

For the variable GDP per inhabitant, we expect a positive coefficient value, because:

1. Assuming that richer countries tend to trade more than poorer countries,
2. Income per capita is the good proxy variable for the expression of infrastructure standards and countries have greater propensity to trade because of a good infrastructure (Fleming, Mueller and Thiemann, 2009).

We assume that the population of the country affects the trading positively. Thus, with growth of the population, we expect growth of exports in selected countries. According to the Walsh (2006) the parameter of variable population can have a positive and a negative sign. Population size, the parameter

of variable population can have a negative impact on foreign trade, when trading nations rely more on internal trade. Absolute difference in relative factor endowments (4) between trading partners at time t is defined by Batalgi (2003):

$$LRFACijt = \left| \ln\left(\frac{GDP_{it}}{capita_{it}}\right) - \ln\left(\frac{GDP_{jt}}{capita_{jt}}\right) \right| \quad (4)$$

where:

$capita_{it}$ – population in the exporting country in the $capita_{jt}$ population in the country of import. Under the new trade theories, one would expect a negative sign for this variable. Adherents of the classical Heckscher-Ohlin-Samuelson theory, on the other hand, expect a positive sign – the larger the difference among the countries in relative factor endowments, the greater the likelihood of mutual trade is. At the macroeconomic level, this is significant at the level of individual economy; we expect lower impact on the variable.

Baltagi (2003) introduced in the study of gravity model variable similarity index size of the economy between trading partners (5):

$$\ln(SIMijt) = LSIMijt = \quad (5)$$
$$= \ln\left[1 - \left(\frac{GDP_{it}}{GDP_{it} + GDP_{jt}}\right)^2 - \left(\frac{GDP_{jt}}{GDP_{it} + GDP_{jt}}\right)^2\right]$$

We expect that the countries with similar economic size trade between themselves more and this relationship is stronger at the macroeconomic level than in specific industries such as wine.

GDP per *capita* is considered a proxy variable output-capacity of the exporting country. The overall *GDP* is particularly suitable for studies which use summary data about export. In the case of specific agro-food products such as table or quality wines, the capacity of output of the country could be overestimated (Carlucci et al., 2008). Therefore, we think also about the physical production of specific goods as an appropriate proxy variable for expression of the home country output capacity (SR). We expect a positive sign variable (c.p.). The higher production of wine, the greater should be the level of its exports.

At the same time the variable *GDP* per capita is included to the model for an explanation of the income effect in the importing countries. We expect a positive parameter of the variable GDP per capita – the higher the individual income, the higher the demand for wine.

The distance between the exporting country and business partners is a proxy variable for the transport costs. Distance between the countries is measured by air distance between the capital cities of the countries. We assume that countries which are more advanced trade more. This happens due to a greater tendency to innovations and better level of infrastructure (Carrilho and Li, 2002).

Dummy variables OECD, EU, WTO are implemented into the model to assess the impact of policies of these groups on bilateral trade of examined countries and variable *MENA* helps to identify the membership impact of trading partners of Slovakia in a monetary union of EU on export of Slovak wines.

Artificial variable JAZ reaches the value 1 if states have a common language base. We assume that the similarity in language increases bilateral trade of countries. For countries with similar linguistic basis we find Slovakia, Czech Republic, Russia and Poland.

ÚHIS represents variable that refers to the common history of territorial countries. Common territorial history of countries should help to stimulate positive foreign trade of countries. Within this group we included Czech Republic, which formed one country with Slovak Republic between 1918 – 1939 and 1945 – 1992, and also Austria and Hungary, which in the period of 1867 – 1918 formed with SR one territorial unit – Austria – Hungary. It is probable that the close relations from the past affect the present goods exchange between countries.

Cross-sectional gravity model

Empirical study includes 19 countries that imported Slovak wines in 2009. Model A (6) is considered to be a basic gravity model where the independent variables are GDP per capita, the size of population of importing countries, the distance of economic centers of the country *j* and *i* etc.:

$$\ln ExpW_j = \gamma_0 + \beta_1 \ln GDP_j + \beta_2 \ln Pop_j + \beta_3 \ln Dist_j \quad (6)$$

In the case of model A only 13.6 % of variability of dependent variable is explained by the model and only GDP per capita is the variable statistically significant at the 10 % level. All parameters of the variables have the expected sign. In order to improve the explanatory ability of the model we use additional variables. Model B (7) was estimated based on the relationship (2) and it can be stated as:

$$\begin{aligned} \ln ExpW_j = {} & \underset{(0.72)}{9.85} - \underset{(0.45)}{1.14} \ln GDP_j + \underset{(0.32)}{0.45} \ln Pop_j + \quad (7) \\ & + \underset{(0.1)}{0.1} \ln Dist_j + \underset{(0.59)}{1.89} \ln EU_j + \underset{(0.93)}{0.29} \ln OECD_j + \underset{(0.24)}{7.86} \ln WTO_j - \\ & - \underset{(0.45)}{2.36}\, MENA_j + \underset{(0.76)}{1.29}\, HRAN_j + \underset{(0.06)}{7.44} \ln JAZ_j - \underset{(0.75)}{1.92}\, ÚHist_j - \\ & - \underset{(0.45)}{4.22} \ln RFAC_j - \underset{(0.70)}{2.48} \ln SIM_j \end{aligned}$$

In brackets is reported *P*-value of the estimated parameters. Adjusted coefficient of determination (R^2 = 0.54) shows the average degree of adjustment of the regression equation. Neither of the parameters is statistically significant at the significance level α = 0.05 and that is why we decided to remove several input variables from the model. That is how model C (8) was created and it represents following relationship:

$$\begin{aligned} \ln ExpW_j = {} & \underset{(0.00)}{21.11} - \underset{(0.00)}{2.08} \ln GDP_j + \underset{(0.06)}{0.52} \ln Pop_j + \quad (8) \\ & + \underset{(0.01)}{9.62} \ln WTO_j + \underset{(0.00)}{7.69} \ln JAZ_j - \underset{(0.00)}{4.18} \ln RFAC_j \end{aligned}$$

The parameter distance – „Dist“ considered as a basis of the gravity model was removed from the basic equation because of its statistical insignificance. Based on the estimated parameters we could evaluate the results. Regression equation with the adjusted coefficient of determination with value 0.705 represents good explanatory ability of the model. All variables (except *Pop.*) have statistical influence at the level 0.05 and at the level 0.1 even the variable "*Pop*" is statistically significant. The estimated coefficients express elasticity directly; therefore, we estimated that if the *GDP* per *capita* rises with 1 %, the export of Slovak wine drop by 2.08 %. In this case we could

conclude that Slovak wine is considered to be inferior good abroad because as the income of inhabitants increases, the demand for Slovak wine decreases. This result is surprising, however, it seems to be real. Based on the model it can be said that if the population increases by 1 %, the demand for Slovak wine increases by 0.52 %. Common language basis of trading countries increased Slovak exports. Membership in the WTO in 2009 also had a positive impact on Slovak wine export, what means that if potential member become a real member of the WTO, the export of Slovak wine will increase by 9.6 %.

As it was expected based on the modern economy theories the sign of this variable is negative. In fact, economies of scale are derived from the international wine trade and differentiation of the products is a common practice.

Signs of significant parameters for all variables except *GDP* per capita have the expected value.

Panel gravity model

The panel model analysis is started with 42 countries, which were importing Slovak wines within the years 2004 – 2010. The data was drawn from INTRASTAT SR database. Time period includes 7 years and because of information unavailability no longer period is possible. Data acquired before the year 2004 would be significant for determination of the impact on Slovak wines export according to Slovak republic's entrance into the EU.

Firstly we found out the explanatory ability of the basic gravity model with the variables as *GDP* per *capita*, population size in the importing state, distance between economic centers in the country and others in time t.

Results of pooled regression – Method 1

Similar to the cross-sectional models, the panel model consisting of a set of basic variables (*GDP* per *capita*, population, distance) is not sufficient to describe the variability of the dependent variable. By the model we described 21.50% of the variability of the dependent variable. After extension of the model for other independent variables and elimination of insignificant variables the explanatory ability of the model increased to 43.07%. Best model (model D) has the form (9):

$$\begin{aligned} \ln ExpQw_{jt} = \underset{(0.00)}{11.57} - \underset{(0.02)}{0.50} \ln PcGDP_{jt} + \underset{(0.00)}{0.58} \ln Pop_{jt} - \\ - \underset{(0.09)}{0.39} \ln Dist_i + \underset{(0.07)}{1.38} \ln SIM_{it} - \\ - \underset{(0.00)}{3.15}\, CUR_{it} + \underset{(0.00)}{1.90}\, FRONT_i + \underset{(0.00)}{2.22}\, LANG_i \end{aligned} \quad (9)$$

We can say that the existence of countries with similar size as the Slovak economy meant for the Slovak export of wines positive fact and the intensity of trade was amplified. Common characteristics of Slovakia's trading partners – the common national borders, common language features – reinforced the bilateral trade with wine. The impact of introducing the common currency (euro) entering the monetary union in 2009 is interesting. We can say, if new trade partner (who is the member of monetary union) came to the Slovak wine export market, the export of Slovak wine would be decreased by 3.15 %. Slovak membership in international organizations and communities does not significantly influence the export of domestic wines. In model we estimated that 1% increase in *GDP* per *capita* decreased the export of Slovak wines by 0.5 %. Slovak wine, according to the results of importing countries is perceived more as an inferior estate.

Results of the pooled regression – Method 2

With the basic model we explained 14.18 % variability. The parameter *GDP* was not significantly different from zero. After the introduction of other independent variables into the model the explanatory ability increased to 28.7 %. In the next step we excluded the most insignificant variables and the best model (model E) can be characteristized by the following equation:

$$\begin{aligned} \ln ExpWj_t = \underset{(0.01)}{29.07} - \underset{(0.00)}{6.30} \ln QwProd_t + \\ + \underset{(0.01)}{1.22} \ln PcGDP_{jt} + \underset{(0.00)}{0.71} \ln Pop_{jt} - \underset{(0.00)}{0.85} \ln Dist_i - \underset{(0.07)}{1.79} \ln SIM_{it} - \\ - \underset{(0.36)}{0.91} OECD_{it} - \underset{(0.12)}{1.6} WTO_{it} - \underset{(0.00)}{2.72}\, MENA_{it} + \underset{(0.33)}{1.50}\, ÚHist_i + \\ + \underset{(0.01)}{3.60}\, HRAN_i + \underset{(0.10)}{1.90} JAZ_i \end{aligned} \quad (10)$$

With the model we explained 29.16 % of the changes in the dependent variable. Every variable in basic model is significant. We excluded variables *RFAC* and EU from the model. Memberships in EU, OECD and in WTO do not significantly affect export of Slovak wines. On the significance level 0.1 we can say, that similar economic size between business partners did not positively influence the export volume. We estimated clear relationship between the size of a domestic production and the volume of the country export. Increase in production of Slovak wine about 1 % could lead to the decrease in wine export volume by about 6.3 %. Similar result justified Carlucci et al. (2008). According to his opinion, international market could not absorb another wine and an increase of domestic production could cause a rapid price drop and consequently export reduction. *GDP, Pop, Dist* are variables, where a parameter has an expected sign. One per cent of population increase in the importing country caused export increase by 0.71 %. The population growth is higher than export growth. As state population is wider concept than wine consumers, naturally, rise of the population does not mean an appropriately high increase in wine demand. Common currency in the countries does not affect the export positively as also the method 1 showed. Common borders between business partners and also common language influence the increase of Slovak wine export on the significance level 0.1.

Conclusions

The article deals with a determination of development tendency in foreign trade with Slovak wine within the years 2004 – 2010. The goal of the article is to identify barriers and positive incentives of the wine export with a help of the gravity model.

Model with cross – sectional data describes relationship between wine export in Slovak republic and explanatory variables the best. However, we found out that distance between business partners in 2009 was not an influencing factor of wine export in Slovak republic. We estimated that an increase of *GDP* of the Slovak wine's importing countries causes a demand decrease of Slovak wine. That means the Slovak wines were inferior goods for foreign consumers in 2009. For Slovak vintners could be this fact warning. It can be appropriate to evaluate if Slovak vintners should further offer wine, which will consumers in target countries substitute with another product, if they want to consume higher quality wine. On the other hand we must say, that this result is very general, because Slovak wine export in our model represents Slovak wine export of the quality various wine types – table wines and quality wines as well.

Also the panel data gave the same image about Slovak wine. In time scale Slovak wines were regarded as inferior goods as well. We also found out that common characteristics of the business partners incite an increase of the product trading exchange. In the first place common language elements of the countries had a positive influence on the export volume from Slovakia to these countries. But also common borders between business partners are a significant factor. An influence of common territorial history between the countries was not confirmed.

In 2009, the fact that among the Slovak business partners were also WTO members had a positive influence on wine export. However this fact cannot be confirmed in longer time period. The panel models did not prove an influence of this value. Memberships in the international organizations OECD and EU also were not the fact which would clearly affect wine export. From all information we can conclude that policies of these international organizations do not fundamentally affect Slovak foreign trade with wine. The impact establishments of the common currency entering the monetary union in 2009 are interesting. Slovakia's entry into monetary union (based on the model) means reduction of wine exports from Slovakia to countries with a common currency, the euro. For example, if trade of new member countries of the monetary union is increasing and absorption of the wine market is limited, it could lead to a decline in the Slovak wine export.

Súhrn

Článok sa zaoberá určením tendencií vývoja exportu slovenského vína v období 2004 – 2010. Cieľom článku je identifikovať bariéry a pozitívne stimulanty exportu vína pomocou gravitačného modelu. Za potenciálne determinanty slovenského exportu vína považujeme na jednej strane základné determinanty gravitačných modelov zahraničného obchodu – HDP na obyvateľa a počet obyvateľov krajín importu, vzdialenosť Slovenska od obchodných partnerov a ďalej faktory, ktoré sú používané v prácach rovnakého zamerania – produkcia domácej krajiny, členstvo v medzinárodných a obchodných organizáciách, spoločné charakteristiky domácej krajiny a obchodných partnerov. Na základe dosiahnutých výsledkov je zrejmé, že gravitačný model prierezového charakteru lepšie popisuje variabilitu závisle premennej (exportu) ako panelový model. Signifikantné premenné sa správajú podľa všeobecne platných predpokladov. Členstvo v EÚ, OECD, WTO boli modelom posúdené ako faktory, ktoré signifikantne neovplyvňujú vývoz slovenského vína. Spoločné charakteristiky obchodujúcich krajín napomáhajú stimulovať vzájomný zahraničný obchod. Ďalším výsledkom je, že slovenské víno je vo všeobecnosti u spotrebiteľov posudzované ako inferior tovar.

Kľúčové slová: zahraničný obchod, determinanty exportu, víno, gravitačný model

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