EXPORT OF AGRICULTURAL PRODUCTS FROM SERBIA TO THE EU - PANEL GRAVITY MODEL

Vladimir Ristanović[1]*, Aleksandra Tošović Stevanović*[2]

**Corresponding author E-mail: vmristanovic@gmail.com*

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ABSTRACT

This paper will analyse the export of agricultural products of Serbia to the EU during the period from 2001 to 2017. A panel gravity model was used to assess the effects of trade flows. The main advantage of the gravity model is the application of basic indicators of the economy and the ability to evaluate panel series. The obtained results show that the size of the economy, measured by gross domestic product, the size of the market of foreign trade partners, measured by population, and the distance between trading partner countries, have measurable effects on the export of agricultural products from Serbia to the EU. Using a simple econometric model, we analysed the effects of Serbia's international trade and noticed that there is significant room for improving the exchange between Serbia and EU members. A multi-variable model would provide more information to trade policy makers.

Introduction

Economic integration has been attracting public attention for decades. This is particularly evident at the regional level, with the escalation of regional integration agreements (RIAs) from free trade areas (FTAs) to customs unions (CUs), all the way to monetary union (MU) such as the EU. For small economies, this type of international cooperation can be of great importance.

For Serbia, a small and open economy, an important development component is foreign trade relations, especially those related to the export of agricultural and food products. Agriculture is the core of the economy and the engine of rural development, but also an important component of the EU accession process. Trade liberalization and the ever-widening global market for agricultural and food products are a chance to improve the export range of agricultural products from Serbia. At the same time, market opening

1 Vladimir Ristanović, PhD, Associate Researcher, Institute of European Studies, Trg Nikole Pašića 11, Beograd, Phone: +381646454415, E-mail: vmristanovic@gmail.com, ORCID ID (https://orcid.org/0000-0002-2957-3465)

2 Aleksandra Tošović Stevanović, PhD, Associate Professor, Faculty of Business Economics and Entrepreneurship, Metropolita Petra 8, Belgrade, Phone: +381641106527, E-mail: aleksandra.tosovic.stevanovic@gmail.com, ORCID ID (https://orcid.org/0000-0003-0281-0579)

can pose a serious threat to certain branches of agriculture, so it is necessary to timely adjust the production structures of the agricultural sector.

Therefore, it is important to consider all relevant parameters and key factors related to agricultural products that are an important topic of international trade, whose characteristics in terms of price and quality are constantly being examined in an open economy.

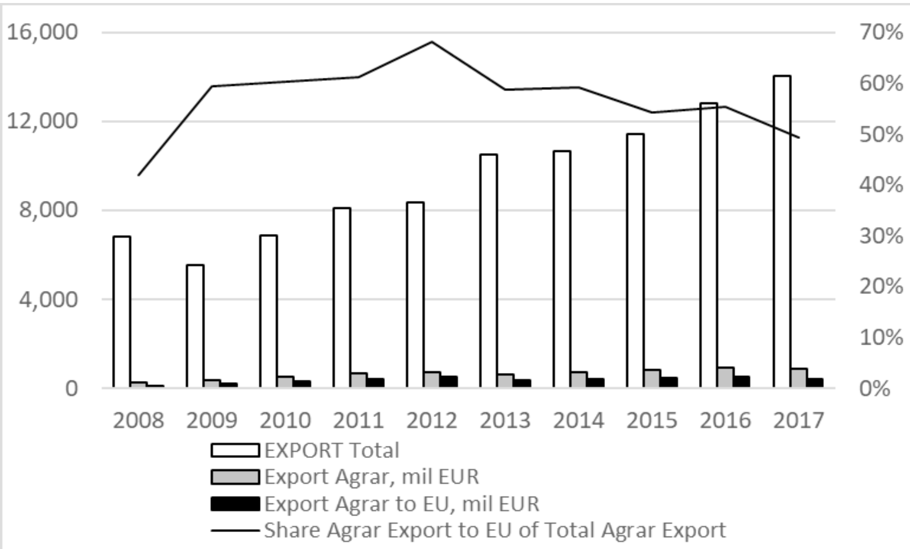
In this analysis, a gravity model was used to estimate the effects of trade flows of agricultural products. The gravity model was estimated on the basis of mutual data exchange between Serbia and 28 EU member states. The emphasis is not on the overall trade potentials, but on the regional orientation of the export of Serbian agricultural products.

Serbian agrarian products export

For decades now, Serbia has had the largest volume of exchange with the EU member states. In 2018, the EU was a key trade partner of Serbia with a share of 67% in its total exports and over 60% in total imports. Exports of Serbian products to the EU in 2018 amounted to 10.9 billion euros.

Among the EU member states, which are traditionally represented with the largest share in foreign trade with Serbia, in 2018 are Italy (12.2%), Germany (11.9%) and Romania (5.9%). In addition to EU members, Russia, China and Bosnia and Herzegovina are at the very top of Serbia's most important trade partners (SORS, 2019).

Figure 1. EU share in total export and agro-food export 2008 - 2017



Source: Authors' calculations

In the observed period, Serbia was mostly focused on the trade with the EU countries, both in total and for agricultural products. The EU market is of great importance for Serbia, especially for agricultural products, where it sells almost half of its agricultural products annually. Having in mind the growing openness of Serbia, high dependence on imports and the deficit in foreign trade, the agricultural sector is becoming a significant factor in balancing the overall trade balance (Božić and Nikolić, 2016).

According to SORS (2019), the export of agricultural products from Serbia has more than doubled in the last decade, with almost 1.3 billion euros in 2018. Producers of cereals, industrial plants and fruits gained profit, and vegetable producers were at a loss, while cattle breeders had almost identical results as in 2017.

Food production is an area in which Serbia has significant export potential, however, as the comparative advantage is not sufficient in itself, domestic export potential of food production is not adequately used due to low competitiveness of domestic food companies, but also the products themselves (Jovović and Jovović, 2018). In order to encourage and increase the level of export of agricultural products to the international market, a gravity model will be presented to assess the effects of trade flows so as to try to understand the decisive factors for improving Serbia's trade with EU member states.

Materials and methods

The gravity model in its basic form, in the literature, has a significant application in the process of explaining bilateral trade. There are numerous research papers (Smarzynska, 2001; Eita and Jordaan, 2007; Viorică, 2012; Waheed and Abbas, 2015; Bialynicka-Birula, 2015; Ristanović et al, 2017; Ranilović, 2017; Ristanović et al, 2019) that explain the effects different economic determinants have (economy size, commodity prices, foreign direct investment, exports, foreign exchange reserves, population, exchange rate, etc.), but GDP, population and distance between countries are the ones which dominate (Oguledo and MacPhee 1994; Eita and Jordaan 2007; Bergstrand 1985 and 1989; Porojan, 2000; Chan-Hyun 2001; Smarzynska, 2001; Ševela, 2002). According to the theory of the gravitational model, exports are positively correlated with the degree of economic growth, negatively correlated with the population of the exporting country, and negatively correlated with the distance between the two economies.

Within the gravity model, the aggregate size of GDP reflects the size or economic strength of the economy, the number of inhabitants in the model represents the size of the market, while distance is a substitute for trade barriers (transport costs in international trade, export / import tariffs, dumping prices, etc.). Through the introduction of a set of three regional variables into the model, it is possible to simultaneously test the effects of grouping on intra-union, non-union, and export trade. Such estimates require the use of panel data to verify potentially inconspicuous factors that are specific to each pair of countries, which will have an impact on trade between them (Trotignon, 2010). In order to examine the individual characteristics of the countries, which participate in the analysis of trade flows, and through which we want to see the mutual trade relations, artificial variables are included in the model.

The influence of specific factors in the gravity model is examined by regression equations with the help of panel series. The advantage of panel series is that they provide the possibility of simultaneous analysis of both comparative data (N) and time series data (T). This increases the sample size (NT) and increases the amount of information from a limited number of observations (sample). The larger the sample, the greater the efficiency of model estimates, at the same time the greater the degree of variability and the greater the degree of freedom. Such a model has less correlation of explanatory variables. Also, the gravity panel model allows simultaneous analysis of both export structures and changes in exports over time. The evaluated results of the model should show the relationship between the size of the economy, the market and the distance, on the one hand, and the export capacities, on the other hand.

All data used to estimate the model parameters come from official sources. The definitions of the model variables and data sources are shown in Table 1. The analysis of trade exchange between Serbia and 28 EU member states covered the period from 2001 to 2017.

Table 1. Defining variables

Variable	Definition	Data Source
exp	Export in current dollars	*Eurostat* and *Trade statistics for international business development*
GDP	Gross Domestic Product of the domestic country in current dollars	*Eurostat* and *Trade statistics for international business development*
GDP*	Gross Domestic Product of the foreign country in current dollars	*Eurostat* and *Trade statistics for international business development*
POP	Population of the domestic country	World Bank annual statistics
POP*	Population of the foreign country	World Bank annual statistics
distance	Distance in kilometres (represents the distance between the capitals)	*CEPII – le Centre d'études prospectives et d'informations internationales*
border	Dummy variables, 0 is the one that takes the value 1 if the countries *i* and *j* have a common boundary, otherwise it is 0	
language	Dummy variables, 0 is the one that takes the value 1 if the countries *i* and *j* have a common boundary, otherwise it is 0	

We assessed the effects of economic development, market size and distance (distance between countries) on the volume of exports of Serbian products to the EU using the gravity model. In addition to these explanatory variables, artificial variables are included in the model. Thus, the extended gravity panel model was tested and evaluated through the impact on exports and from the aspect of common border and common language. To evaluate the model variables, we used two random effect models (RE) and a fixed effect model (FE). In the case of a random effect model, the regression parameters with explanatory variables are invariant, while the random error, i.e. the random variable of the model, reflects variations by units of observation and over time. In the fixed effect model, the random error u_{ijt} has a normal distribution, with zero mean and constant variance, while the explanatory variables are non-stochastic and error-independent. The choice of the model by which the variables will be evaluated are given by the Hausman test. It shows which model, the random effect model or the fixed effect model, will give the best results when testing and evaluating the coefficients with the model variables. Descriptive statistics show that the model contains 280 observations [N = 28; T = 10]. We evaluated the regression model through the statistical software Stata S / E, version 13.0.

Method of Research – Gravity Model

The gravity model was first introduced to economic analysis during the 1970s. It all started with the modeling of trade flows by Tinbergen (1962) and Pöyhönen (1963), and the increasing application to the field of international trade by Linnemman (1966). Aitken (1973) shows that trade between EEC members increased significantly with their integration. In the following decades, the application of the gravity model spread, especially during the 1990s, when the exchange potential of Central and Eastern European countries, on the one hand, and developed Western European countries, on the other hand, was assessed (eg Hamilton and Winters, 1992; Baldwin, 1994; Egger and Pfaffermayr, 2003; Bussière et al. 2005). The differences in results between authors arise not only due to different periods of analysis, but also due to the presence or absence of explanatory variables of the model.

According to the gravity model, potential foreign trade between the two countries is determined by the following determinants of bilateral flows:

1. Demand for imports from the importing country (as a rule, is directly proportional to GDP, and inversely proportional to population),
2. Supply of the exporting country (is represented by the size of GDP and the size of the country - the degree of openness of the economy),
3. Trade barriers: natural constraints, such as transaction costs and transportation costs, other constraints such as, for example, customs and the like.

The Gravity Model has the following form:

$$X_{ijt} = \beta_0 Y_{it}^{\beta_1} Y_{jt}^{\beta_2} POP_{it}^{\beta_3} POP_{jt}^{\beta_4} DIST_{ijt}^{\beta_5} F_{ijt}^{\beta_6} e^{v_{ijt}} \quad (1)$$

where generally speaking *Xijt* shows the total export of the economy *i* to the economy *j* in year *t*; *Yi (Yj)* reflects the *GDP* of the economy *i* and the economy *j* in year *t*; *POPi (POPj)* is the population of economy *i* and economy *j* in year *t*; *DISTij* is a measure of the distance between major economic centers; *Fij* represents any other factors (variables) within the model. The random error of the model is marked with a v_{ijt}. In the general case, a random error consists of three components: individual effects (μ_{ijt}), time effects $(\lambda_t,)$ and the remainder of the random error (u_{ijt}).

$$X_{ijt} = \beta_0 Y_{it}^{\beta_1} Y_{jt}^{\beta_2} POP_{it}^{\beta_3} POPpc_{jt}^{\beta_4} DIST_{ij}^{\beta_5} Bord_{ij}^{\beta_6} Lang_{ij}^{\beta_7} v_{ij} \quad (2)$$

where two artificial variables - common border (Bord) and common language (Lang) -

were introduced. This model basically shows the existence of a linear relationship. The values of some variables vary by country and time, while the values of others vary by country, but are constant over time.

The gravity model uses cross section data, which is a limiting factor because there is a problem of choosing a representative year. Using a panel model solves this limitation. Namely, the gravity panel model can evaluate bilateral exchange in a certain period of time.

As a rule, when using the gravity model to estimate export flows in bilateral trade, the estimated coefficients with variable GDP of the exporting country, *i*, (importer, *j*) are negative, while the coefficients with variable population of the exporting country, *i*, (importer, *j*) are positive. In other words, the growth of the GDP of the importing country, *j*, reflects the growth of the demand for imports, and also with the growth of the GDP of the exporting country, *i*, the export supply is higher. In the model, the variable population is an approximation of market size. The larger the population in the importing country, *j*, the higher the demand for imported products, so the effects on the exporting country, *i*, are positive. However, population growth in the exporting country, *i*, has an ambiguous impact. This impact depends on the effect of absorption, population structure and economies of scale.

The estimated gravity model in a logarithmic form is presented in Equation 3:

$$X_{ijt} = \beta_0 + \beta_1 BDP_{it} + \beta_2 BDP_{jt} + \beta_3 POP_{it} + \beta_4 POP_{jt} + \beta_5 DIST_{ij} + \beta_6 Bord_{ij} + \beta_5 Lang_{ij} + \varepsilon_{it} \quad (3)$$

The model was evaluated by the method of least squares (two-step procedure). Using the Breusch-Pagan test, a standard test to examine the existence of individual effects (variations by country) and time effects (variations over time), their existence was confirmed. Housman's specification test shows that there is no correlation between regressors and individual effects (as components of random error). In other words, the estimates of the regression parameters of the random error component model are unbiased and consistent. This leads to the conclusion that the specification of the panel model of the random error component is more suitable for the model, i.e. model with stochastic effects.

We used the above model to estimate export flows between different countries. In this paper, an analysis of the export potential of agricultural products in regards to the EU economies was conducted based on the results of econometric evaluation of the panel gravity model, for the period from 2001 to 2017. Specifically, the main goal of the analysis is to examine the directions of exchange of Serbian agricultural products with EU countries.

Results and Discussion

We tested the nature of individual effects (fixed and random) using the F-test. The obtained values of the F-test statistics indicate that we accept the null hypothesis - all coefficients in the model are different from zero, the difference that occurs between standard deviations is a consequence of random errors. In other words, the set model is correct. The rule is that if the test shows that we should not reject the zero hypothesis, then the use of a model with a fixed effect is not recommended. In the model, the dependent variable (Y) is explained with the independent variables of the model (*Xi*), which reflects a high level of the determination coefficient (R^2). According to other results, the choice is on the model of random effects. Also, according to the Breusch and Pagan Lagrangian multiplication test for the random effect model, we obtained values that are significant. This means that we reject the hypothesis - there are no individual effects, (Chi-square = 16.77; Prob = 0.0000). In this way, the right choice was additionally confirmed - a panel regression model of random effects. In addition, diagnostic tests were performed, which eased the assumptions of the random effects model (more details in the Appendix).

The results of Table 2 show the regression estimates of the gravity model obtained on the basis of Equation 4. First, the least squares estimation (OLS model) was performed, followed by the estimation of the fixed and random effects models. The evaluation was performed for all variables during the entire observed period. In Table 2, the estimates obtained by the basic least squares model (OLS model) are effective, but the estimates are biased (individual heterogeneities are neglected). The fixed effect model, as a rule, does not estimate coefficients that are time invariant, i.e. variables that do not change over time - distance, common language. In contrast to the fixed effect model, the random effect model encompasses the heterogeneity of all explanatory variables. This allows us to simultaneously estimate the parameters of all model variables, both time-varying and time-invariant.

Table 2. Estimated results for Serbia

Dependent variable: X			
Variables	**OLS model**	**Random effects model**	**Fiksed effects model**
gdp	-5.271971**	-3.646479***	-3.756649***
gdp*	.6336992**	.4144392	1.246826
pop	-23.77332**	-26.66919***	-27.01553***
pop*	.6816342**	.8711883*	-6.877642**
dis	-2.918302***	-3.732251***	0
bord	.1446244**	.082204	0
lang	1.234424***	.9606135	0
_cons	432.1311**	466.3214***	562.1839***
obs	227	227	227
R^2	69.48	70.38	30.13

Note: ***; **; * are statisticaly significant at the level of 1%; 5%; 10%.

Table 2 presents the estimated coefficients from the model. In part, certain signs have been realized, while others are contrary to theory and expectations. The coefficient in front of the variable GDP of Serbia (*gdp*) is statistically significant, and shows a negative impact on the export of agricultural products from Serbia, in all three models. This is contrary to expectations and theory. How to describe the existence of the opposite of the expected impact of Serbia's GDP on the export of agricultural products. In the observed period, the volume of investments in the agricultural sector decreased. The second reason is the structure of household income in Serbia that comes from agriculture and is distributed within the farm. This is especially the case with small farms, which are represented in a high percentage in Serbia (Tošović-Stevanović et al, 2020). At the same time, we should not overlook the fact that the conditions and standardization for access to the EU market are rigorous and almost unattainable for certain agricultural products. The impact of foreign GDP (*gdp**) on exports of Serbian agricultural products is positive (statistically significant), low and reflects the stated expectations. This is understandable if we know that there are high subsidies for agriculture within the EU and that they produce enough food for their own needs. Thus, an increase in the GDP of EU member states of 1% would affect the growth of exports of agricultural products from Serbia by only 0.41%, according to the random effect model. Therefore, by directing exports to the EU, high positive results cannot be expected. Here we are talking about the export of raw agricultural products, not agricultural products of higher stages of processing. Investing in agricultural products of higher stages of processing gives a better export result and highlights the growing contribution of GDP (Dimitrijević et al., 2020). This does not mean that it is necessary to further intensify agricultural production at all costs, as it is often of a devastating nature for the land. Unless there is an intention to introduce innovative, more resource-saving technologies.

The size of the market, which we determined in the model according to the population, has the expected results. Population coefficient for Serbia (*pop*) is statistically significant and has a negative impact on the export of agricultural products from Serbia. This is due to the stronger absorption effect. On the other hand, the impact of the importer population (*pop**) is significant but too low. As with the level of development, we have low elasticity of demand from the EU for these agricultural products from Serbia. The signs of the geographical distance coefficients are statistically significant for Serbia, the exporting country and the EU countries, the countries importing agricultural products (*dis* and *dis**), and they are in line with the expectations. As the distance between the two countries expands, the impact on the export of agricultural products decreases. The common border (*bord*) and the common language (*lang*) do not show significant influence.

Conclusions

Through this paper, we have analysed bilateral trade between Serbia and the EU member states. In addition to assessing the effects of agricultural exports from Serbia to the EU, we used the gravity panel model, a dynamic econometric model that has been presented in practice as a convenient approach to examining multilateral trade flows. We assessed the export-import trade for 28 EU economies and Serbia, in the period 2001-2017.

The presented results of the regression model show that they are statistically significant and explain about 70% of Serbian agricultural exports to the EU using three variable explanations: economic development, market size and distance between countries i and j. Specifically, based on the gravity model of exports of agricultural products from Serbia to the EU member states, it can be stated that there is a statistically significant positive correlation between economic development and market size, and a statistically significant negative correlation when it comes to the distance. Taking into account the defined gravity model, it must be pointed out that the potential inclusion of additional variables in the model could lead to new conclusions important for trade flows.

The model results are expected. All the conclusions derived from the above analysis can be valuable for the makers of economic decisions in finding the best model for improving trade flows between Serbia and the EU members in the future.

Conflict of interests

The authors declare no conflict of interest.

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Appendix

Table A1. Descriptive statistics of Serbian export of the agrarian products in the EU, 2001-2017

Panel A: Descriptive statistics

stats	exp	GDP	GDP*	POP	POP*	distance	border	language
mean	13.55505	33171.69	491187.8	7189280	1.81e+07	1534.393	.1428571	.0714286
max	385.566	36795.4	3263350	7350220	8.27e+07	3283	1	1
min	.0	29766.3	6128.7	7040270	409370	389	0	0
sd	44.88181	1927.727	744402.2	104115.3	2.30e+07	826.1124	.3505537	.2580005
N	280	280	280	280	280	280	280	280

Panel B: Correlation

	exp	gdp	gdp*	pop	pop*	dis	bord	lang
exp	1.0000							
gdp	-0.0860	1.0000						
	0.1969							
gdp*	0.2685*	0.0404	1.0000					
	0.0000	0.5009						
pop	0.0035	-0.6943*	-0.0466	1.0000				
	0.9577	0.0000	0.4570					
pop*	0.4495*	0.0025	0.9125*	-0.0037	1.0000			
	0.0000	0.9674	0.0000	0.9505				
dis	-0.5897*	-0.0000	0.2452*	0.0000	0.0349	1.0000		
	0.0000	1.0000	0.0000	1.0000	0.5614			
bord	0.4493*	0.0000	-0.2106*	0.0000	0.0365	-0.6584*	1.0000	
	0.0000	1.0000	0.0004	1.0000	0.5428	0.0000		
lang	0.1715*	-0.0000	-0.2450*	-0.0000	-0.1917*	-0.3678*	0.2831*	1.0000
	0.0096	1.0000	0.0000	1.0000	0.0013	0.0000	0.0000	

Table A2 Breusch-Pagan/Cook-Weisberg test heteroscedasticity

Breusch-Pagan / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance
Variables: fitted values of exp
chi2(1) = 16.77
Prob > chi2 = 0.0000

Table A3. The variance inflation factor of independent variables

Variable	VIF	1/VIF
gdp*	12.40	0.080644
pop*	10.98	0.091084
bord	2.29	0.437370
dis	2.14	0.467006
pop	1.96	0.509658
gdp	1.96	0.510793
lang	1.28	0.780487
Mean VIF	4.71	

Note: A vif > 10 or a 1/vif < 0.10 indicates trouble.

Table A4. Hausman test

	Coefficients		(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	(b) fixed	(B) random		
gdp	-3.756649	-3.646479	-.1101695	.
gdp*	1.246826	.4144392	.832386	.6939323
pop	-27.01553	-26.66919	-.3463429	.9249085
pop*	-6.877642	.8711883	-7.74883	3.100887

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 6.33

Prob>chi2 = 0.1761

(V_b-V_B is not positive definite)