A Gravity Model of Macedonian Export

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I. Introduction

The gravity model usually is estimated for a group of countries for a certain period of time using cross-section analysis (for a period of one year) or panel methods (for an interval of couple of years). But having in mind that the subject of interest in this article is to estimate the Macedonian export, we will estimate the equation based on bilateral trade movements between Macedonia and importing countries in 2005 using data from the State Statistical Office of Macedonia. This equation, that is based on one country, satisfies the purpose of the article but also enables avoiding of some usual problems that appear using cross-section or panel specification of the gravity model. First, the differences in relative distance of the countries from their trading partners have an influence on integral bias which in cross-section and panel estimation depends on the geographic position of each country[1]. Besides that, the problem of heterogeneity of countries which is common for cross-section and panel analysis can be adjusted using the equation with one country. This is the main reason why such specifications are sometimes used in the literature. The ordinary least squares regression which we will estimate is a simple log-log specification of the following type:

$$(1)\quad \ln \hat{Exp}_i = \beta_0 + \beta_1 \ln GDP_i + \beta_2 \ln Pop_i + \beta_3 \ln Dis_i + \beta_4 \ln CB + \beta_5 \ln FYR + \beta_6 EU$$

where

- Exp is the export of Republic of Macedonia into country *i* in 2005
- GDP is gross domestic product of the country *i* in 2005
- Pop is the population of the country *i* in 2005
- Dis is the air distance in kilometres between the capital of Macedonia and the capital of the country *i*. Data for the distance between capitals are calculated from www.indo.com/distance. The costs of exports probably could be better approximated using the road distance, but that would exclude overseas countries and accordingly the number of trade partners included in the analysis will be reduced.
- CB is a dummy variable for common border which takes 2 for neighbour countries of Macedonia and 1 otherwise[2]
- FYR is a dummy variable for ex Yugoslav republics which takes value 2 if the country is ex Yugoslav republic and 1 otherwise
- EU is a dummy variable for member countries of the European Union which takes 2 if the country is member of EU, 1 otherwise.

The relation between the export and different explanatory variables will be estimated using least squares method.

II. Results of the estimation and analysis

The collected data were processed using the statistical software package Statgraphics Plus 5.1. In the first step, the total of 102 countries in which Republic of Macedonia has exported goods and services in 2005 are included in the analysis. The output below shows these results using Statgraphics Plus 5.1.
The coefficient of determination shows that 57.87% of the variations of Macedonian export is explained by the independent variables included in the model, while the adjusted coefficient of determination which is a better measure for comparing models with different number of explanatory variables is 55.25%. The Durbin-Watson statistic implies existence of negative serial correlation, but if we further calculate the lower and

[1] Brenton, P. and F. Di Mauro, Is there any Potential in Trade in Sensitive Industrial Products between the CEECs and the EU, *The World Economy*, (21), 285-304.
[2] The values 1 and 2 are taken instead of 0 and 1 which are typical for dummy variables because in log-log model it is not possible to calculate logarithm of 0.

upper limits, i.e. 4-1,78(d_u)=2,22 i 4-1,57(d_l)=2,43, we can see that DW statistic is between these two values which implies that test is without decision.

Table I. Output of Statgraphics Plus 5.1 for Macedonan export based on the results from the State Statistical Office of Macedonia for 2005

Dependent variable: Col_4

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	11,4981	2,61129	4,40324	0,0000
Col_1	0,588056	0,152486	3,85647	0,0002
Col_2	0,158754	0,168306	0,943246	0,3479
Col_3	-0,717751	0,278583	-2,57644	0,0115
Col_5	4,95067	1,8292	2,70646	0,0080
Col_6	5,54866	1,70204	3,26001	0,0015
Col_7	2,00281	0,882496	2,26949	0,0255

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	604,27	6	100,712	21,99	0,0000
Residual	439,616	96	4,57933		
Total (Corr.)	1043,89	102			

R-squared = 57,8866 percent
R-squared (adjusted for d.f.) = 55,2545 percent
Standard Error of Est. = 2,13994
Mean absolute error = 1,47179
Durbin-Watson statistic = 2,37614 (P=0,0279)

The observations for which the studentized residuals are greater than 2 in absolute value are given in Table 2. The studentized residuals show for how many standard deviations each of the observed values of the dependent variable deviate from fitted model using all the data except the data for that observation. Using more detailed analysis, we can see that the studentized residuals for Luxembourg, Lebanon, Kenya and British Virgin Islands are greater than 2. But attention has to be paid to residuals greater than 3 in order to see if these countries are outliers and therefore should be excluded from further analysis. In our case the residuals for Luxembourg and British Virgin Islands are greater than 3 and we will exclude them from further analysis. This can be completely justified, especially for British Virgin Islands, because they appeared among the first 25 export markets of the Republic of Macedonia for the first time in 2005. The reason for the great export to this country in 2005 lies in the export of ferronickel through companies registered in British Virgin Islands.[3]

Table II. Studentized residuals of the estimated gravity model (1).

Row	Y	Predicted Y	Residual	Studentized Residual
90	6,31732	12,2811	-5,96382	-3,03
92	7,38236	12,3423	-4,95989	-2,41
93	7,15436	11,7007	-4,54633	-2,20
102	18,2413	8,03189	10,2094	5,77

According to the results in Table III, the new estimated export equation obtained after exclusion of Luxembourg and British Virgin Islands is the following:

$$\ln \hat{Exp}_i = 12{,}3988 + 0{,}7259 \ln GDP_i + 0{,}1316 \ln Pop_i - 1{,}002 \ln Dis_i + 4{,}1714 \ln CB + 5{,}1597 \ln FYR + 1{,}4121 EU$$

(2)							
se	(2,14612)	(0,127779)	(0,142922)	(0,23218)	(1,50545)	(1,39902)	(0,73615)
t	(5,77732)	(5,68087)	(0,920669)	(-4,31641)	(2,77087)	(3,68806)	(1,91826)

[3] Baseski, F., Mojsoska S., Nadvoresnata trgovija na Republika Makedonija: analiza na tekovite na izvozot i uvozot 1994-2005 godina, *Vtora godisna konferencija za unapreduvanje na izvoz*ot, Skopje, 2006 godina

What can we say about the signs of the estimated parameters? Due to the fact that GDP is a measure of the size of the economy, it is normally to expect that if the country's GDP is increasing, the country will import more from abroad. Accordingly to that, the coefficient with GDP is expected to be positive which in our model is.

The population, as a measure of the size of the country, should show us the degree of self sufficiency of the country and accordingly the level of openness of its economy (greater economy-greater self sufficiency-smaller import). In the gravity model, the distance is a factor of resistance and has negative influence on the volume of bilateral trade. The larger the distance between the exporting country and the importing country, the smaller the export.

The distance is a factor which is used as an approximation for capturing the impact of transportation costs and other costs of transaction. One of the main barriers in trade movements are higher transportation costs. As a result of that it is expected the coefficient β_3 to be negative. Having in mind the fact that a common barrier usually makes the trade easier, we expect the elasticity of this variable (CB) to be positive. There is also a set of dummy variables included in the model in order to enable inference about what are the differences in the volume of export caused by the fact "to be in the same region" or "to be a EU member" are.

If we analyse the *t* ratios of each of the regression coefficients, we can realize that at significance level of 0.05, the coefficients β_2 and β_6 are not statistically significant, which can be used as an indicator of their exclusion from the model in order to simplify the model. But if we apply the significance level of 0.10, than the coefficient β_6 is statistically significant, therefore we are going to keep the variable EU in further analysis. The new model estimated after exclusion of the variable Pop is:

$$\ln \hat{Exp}_i = 11{,}6195 + 0{,}816587 \ln GDP_i - 0{,}93969 \ln Dis_i + 4{,}21918 \ln CB + 5{,}1135 \ln FYR + 1{,}17905 EU_i$$

(3)						
se	(1,97057)	(0,08133)	(0,23115)	(1,50335)	(1,397)	(0,690694)
t	(5,89655)	(10,0409)	(-4,25684)	(2,80652)	(3,66035)	(1,70704)

III. Implications of model estimates

Based on the model estimates, we can compare the actual to the estimated (potential) export and according to that make some conclusions. Trade relations between Macedonia and EU in 2005 using the estimated gravity model equation show lower level of the actual comparing to the potential export with the following countries: Hungary, Ireland, Poland, Slovakia, Latvia, Austria, Estonia, Denmark, Finland, France and Slovenia. Macedonian export was over the potential level with Germany (for more than nine times), Belgium and Holland (for more than five times), Italy and Portugal (for more than three times), Malta (for more than twice) and the actual export to Sweden, Greece, Latonia, Spain, Greece, Czech Republic and Great Britain a little bit over the potential level. According to the gravity model estimates, Macedonian exports to some of EU countries such as Ireland, Finland and Estonia are unnaturally lower than the potential levels, but that does not allow us to conclude that the chance for a significant increase of Macedonian exports lies in these countries, because Macedonian export is traditionally low in these countries, therefore it can not increase the Macedonian export in total.

If we analyse the Macedonian export in the period 1994-2005 we can realize that the most important importing countries for Macedonia are: Serbia and Montenegro, Germany, Greece, Italy, Croatia, Bosnia and Herzegovina, Turkey, Holland, USA, Great Britain, Belgium, Slovenia, Albania, Russia, France, Spain, China, Austria, Japan, Sweden, Thailand, Switzerland and Portugal. Therefore, the future of increasing of Macedonian export can be seen in better utilization of the export potential with Slovenia, France and Austria. As far as the ex Yugoslav republics are concerned the greatest possibility for increasing of Macedonian export is with Serbia and Montenegro which currently is the most important trade partner of Macedonia.

We have to keep in mind that the conclusions based on the estimated gravity model should be carefully made, especially when comparing the estimated results between different econometric specifications because the different parameter estimates give different residuals, i.e. different actual to potential ratio. Therefore, the conclusions based on the gravity model equations in this paper as well as the interpretation of the results can not be treated as a final illustration of the Macedonian export potential.
Table III. Actual and potential exports of Republic Macedonia to EU countries and countries of ex Yugoslavia in 2005.

Country	Actual export in US $	Potential export in US $	Ratio actual/potential export
Hungary	2700840,199	5764332,96	0,46854341
Ireland	53082,26815	2484296,3	0,02136712
Italy	169605855,2	47393706,3	3,57865777
Portugal	6760151,963	2079005,06	3,25162843
Poland	4041710,286	7087193,64	0,5702836
Sweden	8335351,264	4957935,59	1,68121411
Slovakia	1482337,798	2368577,21	0,6258347
Latvia	298555,6272	453749,245	0,65797493
Holland	44579408,77	8680589,51	5,1355278
Malta	891339,55	354690,196	2,51300871
Latonia	979704,2704	778870,444	1,25785267
Austria	9000764,646	10545396,8	0,85352546
Cyprus	5541712,254	580822,22	9,54115056
Czech Republic	6049685,656	3827414,24	1,58061952
Germany	364014934,3	39176984,4	9,29155063
Belgium	34620277,59	6040516,02	5,73134439
Greece	312930562,4	242351570	1,29122564
Estonia	22572,82887	335407	0,06729981
Spain	14008263,8	11795161,9	1,18762793
Denmark	2781357,592	4434387,24	0,62722479
Finland	158121,6304	2895591,6	0,05460771
France	19914218,66	24776346,9	0,80375928
Great Britain	42928834,78	22016439,9	1,94985361
Slovenia	31806588,7	68025963,1	0,46756543
Total EU	**1083506232**	**519204948**	**2,08685652**
Croatia	81053786,12	37946961,8	2,13597564
Serbia and Montenegro	459544290	1020338223	0,45038427
Bosna i Hercegovina	50456155,49	22693747,4	2,22335054

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RESUME:

The current trend towards conclusion of regional trade agreements as well as the economic and political transformations of Central and Eastern Europe countries which initiate their integration in the world trade system has revitalized the interest in the gravity model of the international trade. The aim of this article is to estimate the Macedonian export using the gravity model based on the bilateral trade movements between Macedonia and its importing countries in 2005 based on the data from the State Statistical Office of Macedonia. Using the equation based on one country, we avoid the problems which appear with cross section and panel specification of the gravity model. The estimation of the gravity model has been done using the statistical software package Statgraphics Plus 5.1. According to the results of the model and the ratio between the actual and potential export, some directions for improvement of Macedonian export in the future are suggested.