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INFRASTRUCTURE, TRANSPORT COSTS, AND BOSNIA AND HERZEGOVINA'S TRADE: A GRAVITY MODEL APPROACH

Abstract

This paper examines the impact of transport infrastructure, as an important determinant of transport costs, on trade between Bosnia and Herzegovina and Bosnia and Herzegovina's fifteen largest trading partners. The estimation is based on a gravity model and panel data for the years 2005 to 2014. Transport costs have been estimated on the basis of distance, geography and quality of transport infrastructure, as well as on sets of "dummy" variables, such as the impact of borders, language or "dummy" variables for identifying whether a country is surrounded by land or sea. The results can be summarized as follows: (i) the quality of infrastructure and logistics is an important determinant of trade performance; (ii) the importance of distance is not diminished when the quality of infrastructure is included; (iii) Bosnia and Herzegovina trades with countries with which it shares a common language – *ceteris paribus* – twice as much as with others.

Keywords: Bosnia and Herzegovina, trade, transport infrastructure, gravity model

1. Introduction

In order to meet the needs of trade in goods and services, a transport system needs to be efficient and inexpensive (Limão, Venables, 2001; Behar, Venables, 2010; Rodrigue, 2013). An insufficiently effective transport system would significantly restrict the movement of intermediate goods, which cross borders several times. Remoteness and poor transport and communications infrastructure isolate countries, inhibiting their participation in global production networks (Limão, Venables, 2001). Fujimura and Edmonds (2006) pointed out that cross-border and domestic transport infrastructure together can reduce trade costs and lead directly to increased trade and investment. Reduced trade costs can also indirectly induce increased foreign direct investment (FDI), mainly through intra-firm vertical integration across borders that exploits the comparative advantages of each location, and in turn, such increases in FDI can further increase regional trade, adding to the direct effect of trade expansion.

Although trade liberalization has an effect on trade barriers reduction, transport costs, which are nowadays only partly dependent on trade liberalization, are a barrier to trade at least as large as, and frequently larger than, tariffs (Baier, Bergstrand, 2001; OECD, 2005[1]; Hummels, 2007). OECD Trade Policy Study (2005) suggests that a small reduction in transport costs leads to a significant increase in trade. This applies to developing and developed countries alike, but developing countries would gain greater relative benefit from trade in higher rates of economic growth because of the relative inefficiency of the current system.

The overall purpose of this paper is to investigate the exogenous impact of transport costs on Bosnia and Herzegovina's trade, as well as to study the influence of transport infrastructure quality on the trade capabilities of selected economies. To amplify the level of trade between the countries, it is very important to understand the magnitude of the barriers to trade and the determinants of transport costs. Research into the role of transport infrastructure quality in trade between Bosnia and Herzegovina and fifteen major foreign trade partner countries is the main goal of this paper. In examining the relationship between trade and transport costs we used panel data estimations to attribute interdependent nature of transport costs-related factors.

Transport costs in this paper rely on the Limão and Venables (2001) model in which transport costs depend both on countries' geography and on their levels of infrastructure. The geographical measures are distance between countries, whether they share a common border, and whether they are landlocked or are islands. The infrastructure measures relate to the transport infrastructure quality and communications infrastructure.

The paper is organized as follows. Section 2 provides a theoretical framework of investigation and briefly discusses the role of transport costs on trade. Section 3 presents the data in a gravity model and the investigation methodology used in the empirical analysis of panel data. Section 4 discusses the results and policy implications. Finally, conclusions are given in section 5.

2. Literature Review of the Transport Costs

The importance of the transport sector in trade and in the process of economic development is not exactly defined. There are two opposing views on the importance of the transport sector on economic performance. The first group of authors argue that there is a certain, but weaker effect between GDP and the transport sector (see for example Narayana, Kei-Mu, 1997; Demetriades, Mamuneas, 2000; Nijkamp, Poot, 2002). In contrast to the above research findings and views, other authors argue that especially investments in transport infrastructure have a positive impact on GDP (see for example Barro, 1991; Canning, Fay, 1993; Victoria Transport Policy Institute, 2003[2]).

Ismail and Mahyideen (2015) found that improvement in all transport infrastructure sectors resulted in an increase in trade flows. Behar and Venables (2010) concluded that transport infrastructure quality could offset the geographical disadvantage faced by some countries. Bearing in mind that trade improvement measures affect various economic sectors through a reduction of transport costs, the OECD Trade Policy Study (2005) pointed out that the developing countries achieved two thirds of total benefits arisen from such trade improvement. Crafts et al. (2005)[3] showed that the reduction of transport costs in the last 40 years was to be credited for the growth of United Kingdom trade from 10% to 17.5% and the GDP from 2.5% to 4.5%. Analysing the role of the transport system in raising the level of productivity of the United States economy, Aschauer (1989) found that the growth of public capital fund of one per cent might increase GDP between 0.38 and 0.56 percent per annum.

Countries' geography, quality of transport infrastructure, institutions, technology, distance and other factors determine different transport costs across the countries. Studies that looked at the relationship between trade and transport infrastructure quality found a positive and significant impact of transport infrastructure quality on trade (Limão, Venables, 2001; Anderson, van Wincoop, 2003; Clark et al., 2004; Nordås, Piermartini, 2004; Brun et al., 2005; Donaubauer et al., 2015; OECD/WTO, 2015[4]). Distance matters for a few major reasons. First, the effect of distance on trade patterns does not diminish over time (Leamer, Levinsohn, 1994). Second, distance is a proxy for transport costs (Limão, Venables, 2001; Martínez-Zarzoso, Suárez-Burgueta, 2005; Giuliano et al., 2013). Third, distance indicates the time elapsed during shipment. Fourth, transport costs are correlated with the costs of searching for trading opportunities (Nordås, Piermartini, 2004). Fifth, distance influences costs of synchronization and communication in cases when factories combine multiple inputs in the production process (Juvenal, Santos Monteiro, 2010), and finally, greater geographic distances are correlated with larger cultural differences, which can impede trade (Batra, 2013). Technological progress has a strong influence on the entire infrastructure and economy. Different sectors, such as energy, telecommunications, etc. determine the size of transport costs and indirectly determine the rate of economic growth. Hummels (1999) estimated the technological relationship between freight rates and distance and found that varying distances of each importer (evaluated at the country mean weight/value ratio) had the distance elasticity of 0.27. Martínez-Zarzoso and Márquez-Ramos (2005) estimated a gravity equation augmented with technological innovation and transport infrastructure variables in order to analyse the impact of these variables on international trade and found that investing in transport infrastructure and technological innovation led to the improvement and maintenance of the level of competitiveness. Moreover, they found that countries tended to trade more when they were "closer" from a technological point of view.

The costs of trade are the lowest among trading partners who know each other and who have some experience with the reliability of delivery. The costs of search are directly related to the degree of information availability, the possibility of access to and exchange of information. Trade between countries with a common language or other cultural characteristics is carried out more efficiently than operating with less-known partners. For the purpose of exploiting these advantages, companies are trying to find providers or customers just in close countries. Therefore, a common language, common border and other variables that represent common factors are implemented in the gravity models of international trade (see for example Head, Mayer, 2014). The impact of borders is also named as a home bias in trade.[5] Obstfeld and Rogoff (2000) nominated the home bias in trade as one of the six major puzzles in international macroeconomics, as well as transport costs which may partially be explained by the home bias in trade. The value of transport costs also depends on the quality of institutions. Ineffective institutions and bad governance increase transaction costs and reduce international transport flows (de Groot et al., 2005).

3. *The Model, Data and Methodology*

3.1 Model Specification

The gravity model, as part of international trade theory, is a well-known empirical method of analysis of international trade. The model is based on Newton's law of universal gravitation, which states that the force of gravity between two objects is proportional to their mass and inversely proportional to the square of the distance.

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2} \qquad (1)$$

Where F_{ij} is gravitational attraction, M_i, M_j mass of objects, D_{ij}^2 the distance between the two objects, G a gravitational constant for mass and force. In 1962, Jan Tinbergen proposed that roughly the same functional form could be applied to international trade flows. Since then, the gravity model has been applied to a whole range of scientific fields, including foreign direct investments, migrations, tourism, and so on. This general gravity law for international trade may be expressed as follows:

$$F_{ij} = G\frac{M_i^{\alpha} M_j^{\beta}}{D_{ij}^{\theta}} \qquad (2)$$

Where F_{ij} is measured as a monetary flow (e.g. trade values) from origin i to destination j, Mi and Mj are the gross domestic product (GDP) of each location and represent the economic size, D_{ij} the distance. In this paper, it has been assumed that $\alpha = \beta = 1\ and\ \theta = 2$ and we return to Newton's Law (equation 1).

Gravity equations are good at explaining trade with just the size of economies and their distances. However, there is a large amount of variations in trade that gravity equations cannot explain, but there are a few other variables with less theoretical justification we can use to explain trade. The multiplicative nature of the gravity equation means that we can take natural logs and obtain a linear relationship between log trade flows and the logged economy sizes and distances:

$$lnM_{ij} = a_0 + a_1 lny_i + a_2 lny_j + a_3 lnd_{ij} \qquad (3)$$

M_{ij} represents the trade flow from country i to country j, y represents GDP in PPP and d is the distance.

In order to investigate the impact of other important variables on trade, we employ two other equations. Equation four is intended to capture the effects of transport costs and effects of the "dummy" variable on trade. The dummy variable in this paper is the impact of the border, common language, colonial links, access to the open sea and logistic quality.

$$lnM_{ij} = a_0 + a_1 lny_i + a_2 lny_j + a_3 lnd_{ij} + a_4 lninfr\_BiH_i + a_5 lninfr\_partner_j + a_6 border_{ij} + a_7 common\_language_{ij} + a_8 land\_locked_{ij} + a_9 colonial\_links_{ij} + a_{10} logistics\_quality_{ij} \quad (4)$$

Equation five is meant to correct an omitted variable bias when tariff rates are not included and to replace transport costs with trade costs. The gravity equation is typically used to measure the impact of trade costs on bilateral trade flows, but it can also be decomposed into transport costs and policy related costs. The idea is to solve a theoretical gravity equation for the trade costs term instead of transport costs and to express these costs as a function of the observable trade data (Anderson and Wincoop, 2004, Nordås and Piermartini, 2004).

$$lnM_{ij} = a_0 + a_1 lny_i + a_2 lny_j + a_3 lnd_{ij} + a_4 lninfr\_BiH_i + a_5 lninfr\_partner_j + a_6 border_{ij} + a_7 common\_language_{ij} + a_8 land\_locked_{ij} + a_9 colonial\_links_{ij} + a_{10} logistics\_quality_{ij} + a_{11} \ln(1 + tariff) \quad (5)$$

3.2 The Data in Gravity Models

Table 1 shows the dataset which consists of a real data panel for the period 2005-2014 and 15 observed countries. The data panel is strongly balanced and yields together 150 complete observations, which contain trade flows, GDPs, transport infrastructure qualities, distances, international trade tariffs, logistic qualities and a set of dummy variables. Trade as a core variable in the model will be traded as a dependent variable together with the reporter's and partner's GDPs, and their bilateral distance as independent variables. Further, the model is extended by other transport costs measuring variables (quality of transport infrastructure, landlocked, border as a barrier to trade, logistic quality and common language), bilateral tariffs and common colonial history, as economic variables. The state_id and year are variables defining each observation precisely. Annual trade is calculated as yearly export plus import between countries, which are taken from the WITS World Bank database.

Table 1 List of variables

	NAME	VALUES	UNIT	SOURCE
country code	state_id	1-15		
year	year	2005-2014		
ln(trade)	lntrade		US$	WITS World bank
ln(GDP) Bosnia and Herzegovina at PPP	lngdp_bih		US$	IMF
ln(GDP) partner at PPP	lngdp_partner		US$	IMF
ln(distance)	lndistance		km	CPII
ln(transport infrastructure quality) Bosnia and Herzegovina	lninfr_bih		index	own estimation
ln(transport infrastructure quality) Bosnia and Herzegovina	lninfr_partner		index	own estimation
common language	commonlanguage	0/1	dummy	CPII
common border	border	0/1	dummy	CPII
common colonial history	colony	0/1	dummy	CPII
landlocked	landlocked	0/1	dummy	CPII
logistic quality	logistic_quality	0/1	dummy	own estimation
ln(bilateral tariffs)	lnbilateral_ tariffs	0-100	per cent	World bank

Source: Authors' calculations

As can be seen in Table 2 below, Bosnia and Herzegovina trades mainly with neighbouring countries, such as Croatia and Serbia, as well as with countries that are Bosnia and Herzegovina's traditional partners, such as Germany and Italy.

Table 2 Bosnia's main trade partners in 2014

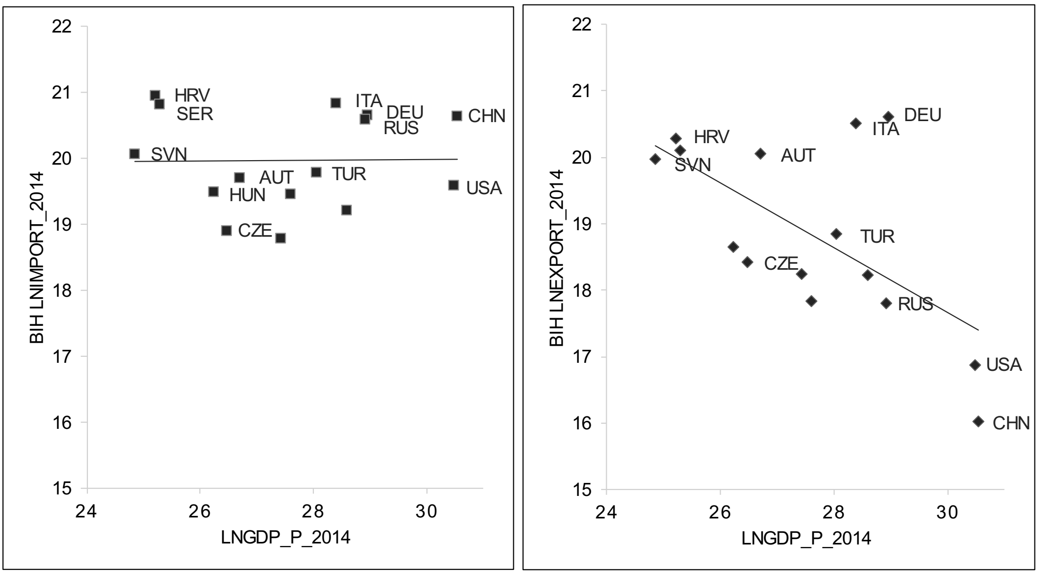
Austria	5.17%	Italy	11.46%	Russian Federation	5.51%
Czech Republic	1.56%	China	5.52%	USA	2.04%
France	1.80%	Hungary	2.49%	Slovenia	5.87%
Netherlands	1.35%	Germany	10.89%	Serbia	9.74%
Croatia	11.28%	Poland	2.00%	Turkey	3.26%

Source: WITS World Bank, authors' calculations

The product of GDP of Bosnia and Herzegovina and 15 biggest trading partners in time is used as a measure of economic size. Gross domestic product is based on purchasing-power-parity (PPP) and valuation of GDP of a country, which is taken from the International Monetary Fund, World Economic Outlook Database.

Although the gravity equation is based on the grounds that trade should exhibit size effects for the exporter and the importer, from the presented trade data for Bosnia and Herzegovina it can be concluded that exports from Bosnia and Herzegovina, although there is a dependency, are not directly related to the economic strength of the importer countries (Figure 1).

Figure 1 Bosnia and Herzegovina's imports and exports in 2014

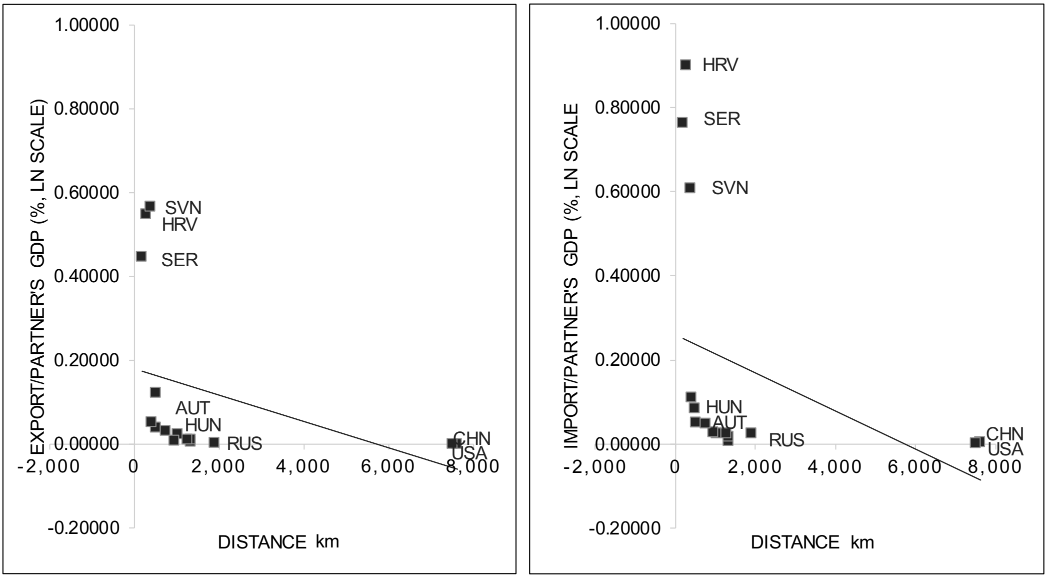


Source: WITS World Bank, authors' calculations

The lines show the predicted values from a simple regression of log trade flow on log GDP. Similarly, it can be concluded that the imports into Bosnia and Herzegovina are not directly dependent on the economic strength of the exporter countries.

The distance between two trading countries was calculated on the basis of a weighted formula developed by Head and Mayer (2002) that includes latitude, longitude and population data of main agglomerations in these countries. The distance variable is also logarithmised in order to obtain the elasticity and a negative relationship can be expected here, since the distance variable represents a certain form of shipping costs (Limão, Venables, 2001). Figure 2 shows, as expected, negative correlation between trade and distance.

Figure 2 Bosnia and Herzegovina's relationship between distance and exports and imports



Source: WITS World Bank, authors' calculations

In establishing the base proxy variable for transport costs we followed the new economic geography literature and focused on an aggregated indicator of transport infrastructure quality, which is constructed from the indices of transport infrastructure quality taken from the World Development Indicators – World Bank database. An aggregate indicator of transport infrastructure quality has been constructed by following Limão and Venables (2001). Each country's infrastructure is measured by an index constructed from five variables: kilometres of road, kilometres of rail (each per sq. km of country area), number of paved airports per sq. km of country area, internet users per 100 people and mobile phones per 100 people. Because of a high correlation among these variables and because of the impossibility to identify separately their influence on transport costs, an index was built with the use of principal components. The indicators were first normalized in order to have the same mean, 1, and then data took the linear average form over the five variables. Finally, this measure was raised to the power –0.3. The reason for this is that infrastructure is an input to the transport services production function, which might be written as: (Cobb Douglas).

In general, this index ranks transport infrastructure quality relative to the standards of trading partners. Transport infrastructure quality variable, presented in Table 1, is expected to be positive and significantly correlated to the GDP.

Table 3 Pairwise correlation between transport infrastructure quality indices and GDP PPP

lngdp_bih	lninfr_bih		lngdp_partner	lninfr_partner	
lngdp_bih	1.0000		lngdp_partner	1.0000	
lninfr_bih	0.1222	1.0000	lninfr_partner	0.3483	1.0000

Source: World Development Indicators-World Bank (2016) and authors' calculations

Estimated correlation coefficients between transport infrastructure quality and economic performance suggest that a positive, significant, and quite strong correlation exists.

Descriptive statistics of transport infrastructure quality data are presented in Table 4. There are considerable cross-country variations. For instance, internet users per 100 people range from 8.5 in China to 93.95 in the Netherlands. The difference in the railway lines km per 100 square km between the Russian Federation and Germany is even greater.

Table 4 Transport infrastructure quality

	Median		Minimum		Maximum	
Internet users per 100 people	60.46	Poland	8.5	China	93.95	Netherlands
Mobile phones per 100 people	109.85	Hungary	30	China	165.5	Netherlands
Railway lines km per 100 square km	5.72	Italy	0.51	Russian Federation	12.47	Germany
Roads km per 100 square km	132.08	Austria	5.23	Russian Federation	411.39	Netherlands
Airports No. per 1000 square km	0.3	Italy	0.036	Russian Federation	0.95	Germany
Aggregate indicator	64.41	Poland/ Slovenia	14.95	China	134.49	Netherlands

Source: World Development Indicators-World bank; CIA Fact Book 2014; Eurostat; UN Data Base; National Bureau of Statistics of China

In trading relationships, other factors such as history, culture, language and social relations also have important effects on trade. Language is included as a proxy for this type of relationship between countries. The common language variable is a dummy variable. It takes value 1 for a common language in cases of Serbia and Croatia and 0 otherwise. Its coefficient is expected to be positive.

The dummy variable "border" has been used to explain the impact of a common border on trade. Common border takes value 1 for Bosnia and Herzegovina's neighbouring countries, 0 otherwise. Limão and Venables (2001) defined three reasons why border impacted trade. First, neighbouring countries typically have more integrated transport networks, which reduce the number of transhipments, e.g. from rail to road or across different types of rail gauge. Second, neighbouring countries are more likely to have transit and customs agreements that reduce transit times and translate into lower shipping and insurance costs. Finally, the higher volume of trade between neighbouring countries dramatically increases the possibilities for backhauling, allowing fixed costs to be shared over two trips. The adjacency coefficient is expected to be positive.

The dummy variable of a common colonial history equals to unity for those country pairs that have common colonial links. The variable takes value 1 when the partner country has common colonial links, 0 otherwise.

Being landlocked causes a disadvantage in development because it makes trade more difficult and costly. This dummy variable takes value 1 for countries with no sea or ocean access, otherwise 0. However, this policy view is predicated on empirical evidence that is controversial. Carmignani (2015) shows that the development impact of the landlocked status is not limited to trade effects. Other transmission mechanisms are at work and the monetary costs associated with these mechanisms are large.

Logistic quality is a dummy that takes the value of 1 if the quality of the logistic performance index is greater than the average across all countries, and 0 otherwise. Logistic quality measures performance along the logistics supply chain within a country and it is intended to capture infrastructural and institutional contributors to transport costs (Behar, Venables, 2010).

Bilateral tariff rates in the gravity equation are important in differentiating between physical transport costs and policy related costs (Behar, Venables, 2010; Hayakawa, 2011). In contrast to regional economics, trade costs in international economics include not only physical transport costs but also policy-related costs, such as bilateral tariff rates. According to Hayakawa (2011), the gravity studies in international trade, which have never included time-variant trading pair-specific tariff rates, may suffer from serious omitted-variable biases. Calculation of bilateral tariff rates was based on the weighted corresponding trade values, such as yearly export plus import between countries, which are taken from the World Bank as applied, weighted mean, all products (%). It is worth noticing that the average value for bilateral tariff rate varies between 2.9 and 1.1. Very high tariff rates are generally associated with trading partners who are not members of the European Union. For example, the highest bilateral tariff rates are between Bosnia and Herzegovina, Russian Federation and Turkey. On the other hand, bilateral tariff rates between Bosnia and Herzegovina and trading partners from the European Union and the Central European Free Trade Agreement (CEFTA) countries have been decreasing over time.

3.3 Estimation Method

A panel data set contains *15* entities, each of which includes *10* observations measured at 1 through *t year* time period. Data are measured at regular year time intervals, well arranged by both cross-sectional and time-series variables and organized as a *balanced panel*. The panel data set is a *fixed panel, hence* the same individuals are observed for each period (Greene, 2008).

The model examines individual-specific effects and time effects in order to deal with *heterogeneity* or an *individual effect* that may or may not be observed. These effects are either fixed or random. Before any econometric estimation technique was applied, we tested whether to use FE or RE. Fixed effects are tested by the F test, while random effects are examined by the Lagrange multiplier (LM) test. The null hypothesis of F-test that all of the regression coefficients are simultaneously equal to zero is strongly rejected: the p-value associated with the F-test is less than 0.01, which means we can reject the null hypothesis at the 1 per cent level. We may conclude that there is a significant fixed effect or significant increase in goodness-of-fit in the fixed effect model.

The LM test helps to decide between a random effects regression and a pooled OLS regression. The null hypothesis in the LM test is that variances across entities are zero. With the large chi-squared of 364.19, we can reject the null hypothesis in favour of the random group effect model. The random effect model is able to deal better with heterogeneity than the pooled OLS.

In our panel model data, we found both significant fixed and random effects. To decide between fixed or random effects, we ran a Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects (see Green, 2008). The null hypothesis of Hausman test is that unique errors (u_i) are not correlated with regressors. We do not reject the null hypothesis ($Prob > chi2 = 0.0951$), and we may conclude that individual effects (u_i) are not correlated with regressors in the model and thus the random effect model is preferred.

Although the gravity equation specification rules out reverse causality, in reality there could be a possibility of reverse causality between Bosnia and Herzegovina's GDP, transport infrastructure quality and trade. To check for the potential endogeneity between trade, Bosnia and Herzegovina's GDP and transport infrastructure quality, Davidson and MacKinnon (1993) suggest an augmented regression test (DWH test), which can easily be formed by including the residuals of each endogenous right-hand side variable, as a function of all exogenous variables, in a regression of the original model. The results of the endogeneity test rule out reverse causality between Bosnia and Herzegovina's GDP and trade. Durbin (score) and Wu-Hausman statistic has p value 0.302 and 0.324 respectively, indicating that Bosnia and Hercegovina's GDP can be treated as an exogenous variable in the gravity equation. The results of the endogeneity test also rule out reverse causality between Bosnia and Herzegovina's transport infrastructure quality and trade. Durbin (score) and Wu-Hausman statistic has p value 0.215 and 0.234 respectively.

The null hypothesis of no serial correlation is strongly rejected. The Wooldridge test for autocorrelation in panel data yields results – p-value of 0.024. The Breusch-Pagan/Cook-Weisberg test for heteroscedasticity rejects null hypothesis of no heteroscedasticity. Hence, the panel data set has both autocorrelation and heteroscedasticity problems. In presence of both serial correlation and heteroscedasticity, Beck and Katz (1995) suggested FGLS (xtgls) or OLS with panel-corrected standard errors (PCSE) (xtpcse), which calculates panel-corrected standard error (PCSE) estimates for linear cross-sectional-time-series models where the parameters are estimated by either OLS or Prais–Winsten regression. When computing the standard errors and the variance–covariance estimates, xtpcse assumes that the disturbances are, by default, heteroskedastic and contemporaneously correlated across panels. Since the analysed dataset has 15 panels and 10 time periods, FGLS is of course ruled out (Beck and Katz 1995), and we proceeded with the xtpcse.

4. Results

This section reports on the results of the regressions for the four sets of estimated gravity equations. Bosnia and Herzegovina's total trade is presented in Table 5. The first column shows the results for the traditional gravity regression. The second column shows the results of the second gravity equation that analyses the additional resistance caused by transport costs, information costs and "dummy" variables, which represent the impact of the border, common language, colonial links and access to the open sea and logistic quality. The third column, in addition to column two, shows the role of trade costs on bilateral trade flows.

Estimating equation (3) for Bosnia and Herzegovina's trade with the use of regression with the panel-corrected standard errors gives rise to the estimated coefficients and associated standard errors, as reported in the first column of Table 5. The results for the traditional variables in column 1 are as expected. All coefficients have the expected signs and independent variables are significant. Both partner's and domestic GDP have, as expected, positive impact on bilateral trade. A one percent increase in Bosnia and Herzegovina's GDP increases the trade by 0.55%, whereas a one percent increase in distance reduces Bosnia and Herzegovina's trade by 1%. Distance from important markets is likely to be a disadvantage to trade (Giuliano et al., 2013; Head, Mayer, 2014; Golub, Tomasik, 2008; Cheng, Wall, 2005).

The results of the second estimation, presented in column 2 of Table 5, shows trade variables, such as transport infrastructure quality and dummy variables, which represent the impact of the border, common language, colonial links, access to the open sea and logistic quality. Bosnia and Herzegovina's transport infrastructure quality seems to influence Bosnia and Herzegovina's trade in a negative way, which is in line with previous hypothesis. It is significant at 1% and on the basis of the value of the coefficient it can be concluded that a rise in Bosnia and Herzegovina's transport infrastructure quality by one percent increases Bosnia and Herzegovina's trade by 2.17%, whereas a one percent increase in distance reduces Bosnia and Herzegovina's trade by 1.27%. The distance parameter when we control the transport infrastructure quality is as expected. It suggests that the improvement of Bosnia and Herzegovina's transport infrastructure quality will result in Bosnia and Herzegovina's trade rising more than the reduction with distance rise of one percent. Interestingly, the coefficient for partners' transport infrastructure turns out to be insignificant, though its sign is still negative. This insignificant result implies that a significant part of the impact of the partners' transport infrastructure quality could be explained by time-invariant specific parameters. The coefficients of both partners' and domestic GDP, 0.14 and 0.95 respectively, indicate that GDP is an important determinant of bilateral trade. Trade between Bosnia and Herzegovina and landlocked countries is reduced by 67% but common language, contiguity and common colonial history seem to have the effect of growth in trade by 166%, 61% and 177%, respectively. Logistic quality has, according to the model, a positive impact coefficient of 0.59. Such a sign was expected, since logistic quality represents a positive impact of similar transport systems between Bosnia and Herzegovina and trading partners.

Bilateral tariff rates in gravity equation 5 are important in differentiating between physical transport costs and trade costs, which have a relatively large and negative impact on bilateral trade. A 1% increase in the bilateral tariff factor (one plus the tariff rate) relative to the weighted tariff rates of Bosnia and Herzegovina's trading partners would reduce bilateral trade by more than 7%. This estimate is similar to (for example Limão, Venables, 2001; Nordås, Piermartini, 2004; Robertson, Estevadeordal, 2009).

Table 5 Results (OLS with PCSE)

	(1) est1	(2) est2	(3) est3
lngdp_bih	0.55***	0.14*	0.17**
	(0.05)	(0.09)	(0.07)
lngdp_partner	0.49***	0.95***	0.95***
	(0.05)	(0.09)	(0.07)
lndistance	-1.00***	-1.27***	-1.27***
	(0.08)	(0.07)	(0.05)
lninfr_bih		-2.17***	-2.83***
		(0.63)	(0.64)
lninfr_partner		-0.36	-0.17
		(0.42)	(0.39)
commonlanguage		0.98***	1.11***
		(0.27)	(0.27)
border		0.48**	0.39*
		(0.23)	(0.22)
colony		1.02***	1.03***
		(0.26)	(0.27)
landlocked		-1.10***	-1.04***
		(0.30)	(0.29)
logistics_quality		0.59**	0.54**
		(0.28)	(0.26)
lnbilateral_tariffs			-7.12***
			(2.02)
Observations	150	150	150
Adjusted R^2	0.999	0.999	0.999

Standard errors in parentheses
* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$
Source: Authors' calculations

5. Conclusion

This paper has provided additional evidence for explaining transport and trade costs and their impact on Bosnia and Herzegovina's trade and vice versa. This has been carried out on the basis of the augmented gravity model pattern, whose log-log transformation was employed and discussed from both a theoretical and empirical point of view. First, a number of indicators of behind-the-border transport infrastructure have been included in the analysis with the goal to explain an impact on transaction costs in Bosnia and Herzegovina's international trade. Second, bilateral indicators for the quality of transport infrastructure have been developed along with "dummy" variables, which represent the resistance of the border, common language, colonial links, access to the open sea and logistic quality with the assumption that transport infrastructure quality is important for trading costs. Third, the introduction of bilateral tariffs made it possible to avoid serious omitted-variable biases and to decompose transaction costs into transport and trade costs.

Transport cost is found to be a significant factor in influencing Bosnia and Herzegovina's trade negatively. This implies Bosnia and Herzegovina would do better if the country traded more with its neighbours. Linking transport infrastructure quality and Bosnia and Herzegovina's trade, it is estimated that a one percent increase in Bosnia and Herzegovina's transport infrastructure quality increases trade by 2.83%, whereas a one percent increase in distance reduces Bosnia and Herzegovina's trade by 1.27%. The size of Bosnia and Herzegovina's economy has a positive and significant impact on trade with an elasticity of 0.17. Also, Bosnia and Herzegovina's trade is found to be influenced to a great extent by border, language and similarity of its transport systems to that of its trading partners. Using the described estimation approach, significant evidence of a negative tariff effect on trade was found.

The policy implications of the results obtained are that transport-trade costs matter, while distance is as important as before.

Future research may focus on more countries and years, as well as on further decomposition of trade into sum of export and import, sum of intra-industry and inter-industry trade. Also, it will be very interesting to find out more about the effects of transportation costs on trade flows between Bosnia and Herzegovina and EU countries.

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5 "Home Bias in Trade" is a widely analysed problem in macroeconomics, which indicates the existence of formal and informal barriers to trade beyond national borders.

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INFRASTRUKTURA, TRANSPORTNI TROŠKOVI I BOSANSKOHERCEGOVAČKA TRGOVINA: PRISTUP GRAVITACIJSKOGA MODELA

Sažetak

U radu se istražuje utjecaj prometne infrastrukture, kao važne odrednice troškova transporta, na trgovinu između Bosne i Hercegovine i petnaest najvećih trgovinskih partnera. Procjena se temelji na primjeni gravitacijskoga modela i panel podataka za razdoblje od 2005. do 2014. godine. Troškovi transporta su procijenjeni na temelju udaljenosti, geografije i kvalitete transportne infrastrukture, kao i na setu *"dummy"* varijabla, kao što su utjecaj granica, jezika ili *"dummy"* varijable za utvrđivanje je li zemlja okružena kopnom ili morem. Rezultati se mogu sažeti kako slijedi: (i) kvaliteta infrastrukture i logistike su važne odrednice trgovine; (ii) važnost udaljenosti se ne umanjuje uključivanjem kvalitete infrastrukture u gravitacijski model; (iii) Bosna i Hercegovina trguje sa zemljama koje dijele zajednički jezik - *ceteris paribus* - 2 puta više.

Ključne riječi: Bosna i Hercegovina, trgovina, transportna infrastruktura, gravitacijski model