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EUROPEAN UNION TRANSPORT INFRASTRUCTURE: ROADS AND RAILWAYS SUBSECTORS CASE

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Abstract

This article tests transport infrastructure‘s roads and railways subsectors impact on economic growth in the European Union during the 1990-2017 years time span. The latest public infrastructure investments trends in those subsectors are analyzed as well. Article’s empirical research encompasses all 28 European Union countries (at that time) data, and fills the gap of such researches in roads and railways subsectors case in the full European Union area. Proxy variables used for roads and railways subsectors are physical type, but with ability to encompass the usage of chosen infrastructure subsectors. It is a new feature in such type of researches, which usually uses either raw physical or raw monetary type of infrastructure variables. The research results show that both roads and railways subsectors have positive short run impact on economic growth in the European Union. Results are almost the same, with overall elasticity coefficients in both subsectors. Though post-2009 public infrastructure investments in these subsectors show declining pattern, in the overall situation‘s context there is no need to worry about it yet.

Keywords: Transport Infrastructure, Roads Subsector, Railways Subsector, Economic Growth, Physical Infrastructure Measures, Public Investments on Infrastructure

1. Introduction

From theoretical approach, infrastructure is one of the main factors of either country’s or region’s economic growth. This phenomenon consists of physical and organizational structures and services which are essential for economic growth. In general, infrastructure can be divided into three major sectors: transport, telecommunications, and energetics. According to Dash and Sahoo (2010), infrastructure contributes to economic growth through (1) direct investments on infrastructure, which create production facilities and stimulate economic activities, (2) transaction and trade costs reduction, which help to improve competitiveness and (3) provision of employment opportunities and physical and social infrastructure to the poor. However, lack of relevant infrastructure can disable proper economic growth and/or poverty reduction.

Transport sector is being considered one of the major sectors of infrastructure. This sector consists of roads, railways, airports and ports subsectors. However, this article mainly focuses on roads and railways subsectors in the European Union, because these two subsectors attract the biggest part of all investments in transport sector. On the basis of the latest available statistical data (up to 2016), during the last five years, public infrastructure investments in the European Union were at 'chronic' low level (Jones, 2017). Among all transport sector's subsectors, transport subsector was affected the most (Barnard, 2018). According to European Environment Agency (2016), since the mid-1990s, public spending on transport infrastructure has increased significantly across European Union countries, reaching a peak in 2009. After 2009, it has subsequently decreased each year, but even despite these reductions, it is still higher than in 1995.

However, if we look deeper at the latest European Union statistical data, current situation in this field is not so obvious, as it can be seen from Jones (2017), Barnard (2018) and European Environment Agency (2016) literature analysis. It should be mentioned, that availability of statistical data in this particular field of interest is not very good. The main reasons for that are methodological, comparison and data availability issues. As for European Union countries data, ITF (2020) transport statistics database's transport performance indicators section can provide quite enough amount of data needed for the overview of the current situation in transport sector's roads and railways subsectors in the European Union. The available data covers 1995-2016 years timespan and 22-23 out of 28 European Union countries at that time. Based on public infrastructure investments per GDP indicator for the whole 1995-2016 years timespan, it could be said that in both roads and railways subsectors there are no clear trends. During this timespan, equal number of countries in both roads and railways subsectors faces either growth or decline trends. However after the year of 2009, in both subsectors public investments show declining pattern, which can be found in 2/3 of the analyzed countries data. Meanwhile, according to public transport infrastructure, investments in constant USD per inhabitant indicator, in both subsectors investments show growing pattern during 1995-2016 year timespan in 2/3 of the analyzed countries data. However, after the year 2009, there is declining pattern in public investments in almost 3/5 European Union countries.

According to such findings, current situation can be described the following: the main public transport infrastructure investments stay almost at the same level during the analyzed time span, but after the peak in 2009 the declining pattern in both roads and railways subsectors can be seen. The main problem at this point is to find out, if such situation is not harmful for European Union countries economic growth, that is, if existing public transport infrastructure investments in roads and railways subsectors are sufficient. The aim of this article is to test whether there is long run or short run relationship between transport sector's roads and railways subsectors and economic growth.

The second section of the article consists of short infrastructure as a phenomena and transport sector's theoretical and empirical literature analysis. The third section of the article consists of recent situation in the European Union analysis, research data properties and research methodology. Article's empirical research results are presented in the fourth section. At the end of the article, conclusions and research shortages are provided.

2. Transport sector's infrastructure impact on economic growth

Before proceeding to empirical analysis of roads and railways subsectors impact on economic growth, short infrastructure as a phenomena description is provided.

2.1. The concept of infrastructure

The concept of infrastructure is quite new in scientific research. It started with seminal work of Tinbergen (1962) where the first difference between infrastructure and superstructure was made. After this work, there was vast of other theoretical research articles in this area with different infrastructure definitions and classifications. According to some scientists (Hansen, 1965; Aschauer, 1989; Sturm *et al.* 1995; Buhr, 2003; Prud'homme, 2004; Baldwin and Dixon, 2008; Grubesic, 2009; Torrisi, 2009) it can be concluded, that infrastructure as a whole and its elements should be durable non-movable good, which is built during the long span of time. Other infrastructure features are conditional absence of substitutes in the short run and ability to be one of the major factors which helps to produce goods or provide services for country's economy.

In theoretical literature, there are two most common infrastructure categories: economic and social infrastructure. With the reference to Fourie (2006), economic infrastructure could be defined as infrastructure that promotes economic activity, such as roads, highways, railroads, airports, seaports, electricity, telecommunications, water supply and sanitation. According to Gabdrakhmanov and Rubstov (2014), social infrastructure could be understood as a complex of municipal entity, constructions and institutions, which provide the necessary material and cultural living conditions of the population on a certain territory, like institutions of science and art, of the general and vocational education, health and social security and construction of sports and recreational facilities. However, economic infrastructure is a more common type of infrastructure in the empirical research.

2.2. Roads and railways subsectors impact on economic growth

As it has been already mentioned in the introduction, transport sector is being considered as one of the major sectors of infrastructure. This sector consists of roads, railways, airports and ports subsectors. Because the main interest of this article is roads and railways subsectors impact on economic growth, empirical researches results on airports and ports subsectors impact on economic growth will not be analyzed. Analyzed authors (Seethepalli *et al.* 2008; Sahoo and Dash, 2009; Dash and Sahoo, 2010; Sahoo *et al.* 2012; Urrunaga and Aparicio, 2012; Xueliang, 2013; Lenz *et al.* 2018; Saidi *et al.* 2018; Zhang and Ji, 2018; Mohanty and Bhanumurthy, 2018) found positive roads subsector's impact on economic growth. In those empirical researches, elasticity coefficients ranged from 0.03 to 0.55. Meanwhile in Egert *et al.* (2009a, 2009b) and Crescenzi *et al.* (2016), it was found mixed results: in some cases there was positive roads subsector's impact on economic growth while in other cases there was negative impact. It should be mentioned that those mixed results were found in empirical researches, which were done using developed countries data, while almost all positive impact cases were found in empirical researches which covered developing countries data. In all those empirical researches, the main proxies for roads subsector were either total roads/motorways length in kilometers, either per specified number of inhabitants or just the total length itself, or paved roads as a percentage from all roads.

In the case of railways subsector's impact on economic growth, the same situation occurs. In Lenz *et al.* (2018), Egert *et al.* (2009a, 2009b) and Snieska and Zykiene (2010), it was found either not statistically significant or negative railways subsector's impact on economic growth in developed countries, but in developing countries cases in Fedderke and Bogetic (2006), Sahoo and Dash (2009), Dash and Sahoo (2010) and Sahoo *et al.* (2012) it was found positive railways subsector's impact on economic growth with elasticity coefficients which ranged from 0.10 to 1.18. In all those empirical researches, the main proxies for railways subsector were either total railways length in kilometers or per specified number of inhabitants, or just the total length itself, or the density of railways per squared kilometer.

It can be seen that in both cases proxy variables for roads and railways subsectors are expressed in physical type infrastructure measures. It is because monetary, especially public investment type infrastructure measures are considered as having too many drawbacks. According to Urrunaga and Aparicio (2012), public investments type infrastructure measures are not reliable due to the fact that public infrastructure investments measure does not necessarily encompass all public infrastructure investments exclusively, that is, some amount of it can be spent on the auxiliary services or structures. Also, the private sector's share in the provision of this type of infrastructure is important too, so the public infrastructure investments measure alone could be insufficient. However, it is difficult to measure the amount invested by firms in public infrastructure due to the reason that private companies try to keep their costs as confidential as possible and usually that type of data are not publicly available. And finally, according to Urrunaga and Aparicio (2012), the investment costs often are not related to the quantity of infrastructure amount that is actually built. Of course, physical infrastructure measures have drawbacks too, because most of the available data do not contain any information on differences in cost and quality (public infrastructure investments measures do not reflect the quality either). For example, the costs of setting up the infrastructure can vary markedly (an additional kilometer of road or rail track would be more expensive if requiring a bridge or a tunnel), while the quality of infrastructure may also vary (well maintained stocks may yield more benefits than poorly maintained ones) (Egert *et al.* 2009a, 2009b). However, physical infrastructure measures in empirical researches are being considered as better ones, because, according to Egert *et al.* (2009a, 2009b), public infrastructure investments measures are becoming more and more unreliable due to corporatization, privatization and market liberalization.

3. Empirical research data and methodology

3.1. Theoretical framework

In theoretical literature, in case of infrastructure it is said that infrastructure is a long lasting long run period good. Due to this assumption, one aim of this article is to test whether there is long run relationship between transport sector's roads and railways subsectors and the economic growth in the European Union during the 1990-2017 years timespan. In case of nonexisting long run relationship, it will be tested whether the short run relationship between this phenomenon exists. The main model is based on the general production function form of:

$$\frac{Y}{L} = A * f(\frac{K}{L}) \quad (1)$$

where: Y/L - output to labor ratio; K/L - capital to labor ratio; A – expression of the technological progress. Further, it is used Cobb-Douglas type production function, so equation (1) becomes to:

$$\left(\frac{Y}{L}\right)_t = A\left(\frac{K}{L}\right)_t^{\beta_2} e^{u_t} \quad (2)$$

where e is base of natural logarithm and u_t is stochastic disturbance term. After subsequent substitutions of $RGDP_t = \left(\frac{Y}{L}\right)_t$ and $INF_t^{\beta_2} = \left(\frac{K}{L}\right)_t^{\beta_2}$ equation (2) takes form of:

$$RGDP_t = A \times INF_t^{\beta_2} e^{u_t} \quad (3)$$

where RGDP depicts proxy variable for economic growth and INF depicts proxy variable for either roads or railways subsector. More information about these variables is given in subsection 3.2.

Finally, natural logarithm is taken of equation (3) which leads to equation (4) and after substitution $\beta_1 = \ln A$ comes the final model (5) for this article's empirical research.

$$\ln RGDP_t = \ln A + \beta_2 \ln INF_t + u_t \quad (4)$$

$$\ln RGDP_t = \beta_1 + \beta_2 \ln INF_t + u_t \quad (5)$$

Model depicted as equation (5) is used for testing both assumptions about roads and railways subsector‘s impact on economic growth, either in the long or in the short run. The main interest of this analysis is β_2, which is elasticity coefficient, sign, size and statistical significance. It must be mentioned, that such (5) equations are tested for each of European Union country individually if the particular country‘s data meet all econometric modeling requirements.

3.2. Research data

Research data consists of three ratio variables, namely real general domestic product (RGDP) per million capita, which is equivalent to economic growth, roads freight transport, expressed in million ton-kilometers per million capita and railways freight transport, also expressed in million-ton kilometers per million capita which both are equivalent of roads and railways subsectors respectively. In this case, freight transport refers to the total movement of goods using inland transport on a given subsector. Research data covers 1990-2017 years timespan and all 26 out of 28 European Union countries at that time, because Cyprus and Malta data for roads and railways subsectors was not available. RGDP data was taken from United Nations (2019) and is measured in constant 2010 prices in national currency. Population statistics were taken from Eurostat database and it is the total population of the country on January 1, except France data from 2014 to 2017, which was taken from Worldometers (2019). Roads and railways freight transport data was taken from OECD (2019).

Such empirical research data choice was made due to two reasons. First, the was no available pure physical type infrastructure measures data (roads and railways total length in kilometers) for both roads and railways subsectors for all European Union countries. Second reason is more subtle. As European Union countries are being considered as developed countries, pure roads and railways infrastructure in those countries is already built. This proxy variable (roads and railways total length in kilometers) for roads and railways subsectors infrastructure may be suitable for developing countries, because in those countries infrastructure phenomenon is in motion, that is, it is still in the development stage and has upward trend, while in developed countries, like in the European Union, such type of infrastructure variables mainly fluctuate about their current values, because all the major amount of infrastructure in particular infrastructure sector is already built. According to those reasons, for this article’s empirical research, there were chosen physical type infrastructure measures, but those, which also encompass such feature like particular infrastructure sector’s usage ratio. Such variables may be the most appropriate in current European Union case.

3.3. Econometric analysis tools

In order to achieve article’s aim, econometric analysis tools should be used. All econometric calculations in this article are made using Gretl program. All of regression analysis is based on ordinary least squares (OLS) method, using the standard 0.05 level of significance value. In order to get elasticity coefficients, natural logarithms of relevant time series data were taken. To test, whether there is evidence of the long run relationship between the variables, Engle-Granger two step cointegration test developed by Engle and Granger (1987) is used. Economically speaking, two variables will be cointegrated if they have a long-term, or equilibrium, relationship between them (Gujarati and Porter, 2008). The cointegration regression equation form is the same as equation (5), with no time trend variable being added. If the long run relationship is found, error correction mechanism (ECM) will be used. In equation (6) ECM equation is provided:

$$\Delta \ln RGDP_t = \beta_1 + \beta_2 \Delta \ln INF_t + \beta_3 u_{t-1} + \varepsilon_t \quad (6)$$

where ε_t is a white noise term and u_{t-1} is the lagged value of the error term in equation (5).

Time series data type is used in this analysis, so the presence of unit roots should be tested first. In this research, the main test to test for unit roots is augmented Dickey-Fuller test (ADF) (Dickey and Fuller, 1979) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski *et al.* 1992) test is chosen as the supplementary test, because sometimes unit roots testing results could be equivocal due to the test specifications or the fact, that relevant time series data exhibits near unit root process. ADF test is used under test down from maximum lag conditions, while KPSS test is used with fixed lag length. Maximum lag length for both tests is calculated using Schwert (1989) l_{12} and l_4 formulas for ADF and KPSS tests respectively.

In order to avoid equivocal situations in unit root testing, the following unit root testing procedure is used:

i. For original logged RGDP per million capita, roads and railways freight transport per million capita data ADF and, if needed, KPSS tests are executed with constant and trend. Then it is executed Φ_3 test (Dickey and Fuller, 1981). If Φ_3 test's H_0 is accepted, ADF, and if needed KPSS tests are executed just with constant; if Φ_3 test's H_0 is rejected, usual t statistic test is used to check the presence of deterministic trend in the data. If trend is found, conclusions about unit root are made from ADF, and if needed KPSS tests with constant and trend specification; but if there is no deterministic time trend, then ADF, and if needed, KPSS tests are executed just with constant and corresponding conclusions about unit roots are made.
ii. For the logged first differenced (if needed) RGDP per million capita, roads and railways freight transport per million capita time series data, it is made t significance test to test, whether time series mean is statistically equal to zero. If it is so, ADF, and, if needed, KPSS tests are executed using without constant (ADF) and around the level (KPSS) test specifications; if no, then ADF, and, if needed, KPSS tests are executed using with constant (ADF) and around the level (KPSS) test specifications.

It should be noted that testing original logged time series data supplementary KPSS test is done just then ADF test results show that data has no unit root. Meanwhile in testing logged first differenced time series data, supplementary KPSS test is used in cases then ADF test results show that there is unit root in the data. Such preferences are made due to two reasons: 1) according to Wooldridge (2013), the notion of cointegration could be applied when two series are I(1), but a linear combination of them is I(0); 2) to model short run model, both variables should be either I(0) or first differences of I(1) variables, which means that either in original data or first differences of variables should be no unit roots. If KPSS test is used, its results are being considered superior to ADF test results. It should be noted that further than I(1) testing is not executed, because regression with higher order than I(1) variables results does not have economic sense.

In order to test the short run relationship between the economic growth and either roads or railways subsectors, the main test equation depends on data peculiarities. If both time series data are I(0), then model equation is like equation (5). If first differences of variables are being used, then model equation for short run relationship testing is in the following form:

$$\Delta \ln RGDP_t = \beta_1 + \beta_2 \Delta \ln INF_t + u_t \quad (7)$$

In order to avoid misleading regression results, first order autocorrelation, heteroscedasticity and normality of residuals tests are made. Breusch-Godfrey (Breusch, 1978; Godfrey, 1978) test is used for testing for the first order autocorrelation, White test (White, 1980) is used to test whether there is heteroscedasticity in model's residuals and Doornik-Hansen (Doornik and Hansen, 2008) test is used for testing normality of the residuals. If either first order autocorrelation or heteroscedasticity, or both are found, heteroscedasticity- and autocorrelation-consistent standard errors (HAC) remedial measure is used. For nonnormal residuals case there is no straight remedial measures. In such case, there are two possibilities: to apply asymptotic theory or to threat regression results with grain of salt.

4. Results

In this chapter, article‘s empirical research results are provided. It consists of two parts: results for long run and short run relationship between economic growth and roads or railways subsectors. All countries codes used in the tables below are presented in the Appendix.

4.1. Testing for long run relationship

As it was mentioned before, in order to check the presence of the long run relationship both variables in the model should be I(1). Since the original sample size is 28 observations for original and 27 observations for the first differenced data, according to Schwert (1989), l_{12} and l_4 formulas, maximum lag for ADF test was 8 and for KPSS test it was 2. At first, all variables were tested for unit roots. After unit root tests were taken, the presence of cointegration in both, roads and railways subsectors was tested. Table 1 shows summary results of this procedure in roads subsector's case.

Table 1. Summary of cointegration testing procedure in roads subsector

	Cointegration exists	*Cointegration does not exist*	*Possible I(2) versus I(0) variables*	*I(1) versus I(0) variables*	I(0) versus I(1) variables
Country code(s)		AUT, BEL, BGR, CZE, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IRL, ITA, LUX, NLD, POL, PRT, ROU, SVN, SWE	DEU	LTU	LVA, SVK

Source: Author's research

As it can be seen from Table 1, in 4 countries due to data peculiarities cointegration existence could not be tested. In the remaining 22 countries data long run relationship between economic growth and roads subsector was not found. Cointegration testing results for railways sector are provided in Table 2.

Table 2. Summary of cointegration testing procedure in railways subsector

	Cointegration exists	*Cointegration does not exist*	*I(0) versus I(1) variables*	*I(1) versus I(0) variables*
Country code(s)	AUT	BEL, BGR, CZE, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IRL, ITA, LUX, LVA, NLD, POL, ROU, SVN, SWE	DEU, LTU	PRT, SVN

Source: Author's research

As it can be seen from Table 2, in 4 countries due to data peculiarities cointegration existence could not be tested either. In the remaining 22 countries data long run relationship between economic growth and railways subsector was found just in 1 country. Due to this reason, there is no need to model cointegrating regression and ECM model for just one country. Because long run relationship between economic growth and roads and railways subsectors was not found, short run modeling should be done.

4.2. Testing for short run relationship

Table 3 shows roads subsector‘s impact on economic growth in the short run. In the column ‘tests’, normality of residuals (first column), autocorrelation (second column) and heteroscedasticity (third column) tests results summary is provided. Those test results are depicted in ‘plus’ or ‘minus’ signs for briefness reason. Positive results for normality test is ‘plus’ sign, while for autocorrelation and heteroscedasticity test ‘minus’ sign shows positive results. In case of existence of autocorrelation either heteroscedasticity, or both, heteroscedasticity- and autocorrelation-consistent standard errors (HAC) remedial measure was used. However, there is no remedial measures for nonnormal residuals, but in this case, 27 observations may be threated as a large sample.

Table 3. Roads subsector‘s impact on economic growth in short run

Country code	β_2 *coefficient*	*Tests*	*Country code*	β_2 *coefficient*	*Tests*
AUT	Not significant	+ / - / +	HUN	0.12[2]	- / - / -
BEL	Not significant	+ / - / -	IRL	0.25	- / - / -
BGR	Not significant	+ / - / +	ITA	Not significant	- / - / -
CZE	Not significant	+ / - / +	LTU	0.24	- / + / -
DEU	N/A	N/A	LUX	0.11	+ / - / -
DNK	0.19	- / - / -	LVA	0.37	- / - / +
ESP	0.24	- / - / -	NLD	Not significant	+ / + / -
EST	0.22	+ / - / -	POL	0.24	- / - / +
FIN	0.25	+ / + / +	PRT	Not significant	+ / - / -
FRA	0.13	+ / - / +	ROU	0.19	+ / - / -
GBR	0.23	+ / + / +	SVK	Not significant	- / - / +
GRC	Not significant	- / + / -	SVN	0.31	- / - / -
HRV	0.16[1]	- / - / +	SWE	0.21	+ / - / -

Note: 1- p value is 0.0509; 2- p value is 0.0858.

Source: Author’s research

As it can be seen from Table 3, 25 out of 26 countries data was eligible for modeling. Germany‘s case was not modeled because roads subsector‘s proxy variable was found to be integrated of higher order than 1. In 9 countries statistically significant roads subsector‘s impact on economic growth was not found. However, in 16 countries such impact was found, with elasticity coefficients ranging in [0.13;0.37] interval. From these results we can conclude that roads subsector has positive statistically significant impact on economic growth in European Union countries.

As it can be seen from Table 4, all 26 countries data was eligible for modeling in railways subsector case. Just in 5 countries cases, there was not found statistically significant railways subsector‘s impact on economic growth. In 21 countries such impact was found, with elasticity coefficients ranging in [0.06;0.52] interval. From these results we can conclude that railways subsector has positive statistically significant impact on economic growth in the European Union countries. This impact in railways subsector case is bigger than in roads subsector case, but results are quite similar with average elasticity coefficients value of 0.23 in both subsectors.

Table 4. Railways subsector impact on economic growth in short run

Country code	β_2 *coefficient*	*Tests*	*Country code*	β_2 *coefficient*	*Tests*
AUT	0.16	+ / - / -	HUN	0.26	+ / - / +
BEL	0.11	+ / - / -	IRL	Not significant	- / - / -
BGR	0.19	+ / - / +	ITA	0.20	+ / + / -
CZE	0.36	- / + / -	LTU	0.50	+ / - / -
DEU	Not significant	+ / - / +	LUX	Not significant	+ / - / +
DNK	0.06[1]	- / - / -	LVA	0.52	+ / + / +
ESP	0.12	+ / + / -	NLD	0.15	+ / + / +
EST	0.21	- / + / -	POL	0.19	- / - / +
FIN	0.19[2]	+ / + / +	PRT	0.13	+ / - / -
FRA	0.12	+ / - / -	ROU	0.28	+ / - / -
GBR	Not significant	- / + / -	SVK	Not significant	- / + / -
GRC	0.10	+ / + / -	SVN	0.20	+ / + / +
HRV	0.27	+ / - / +	SWE	0.39	+ / - / -

Note: 1- p value is 0.0521; 2- p value is 0.0547.

Source: Author's research

At this point, positive roads and railways subsectors impact on economic growth in the European Union was found. The final aim of this article is to check, whether current situation in public infrastructure investments in roads and railways subsectors has any relation with this article‘s empirical research results and what conclusion about the current situation in European Union public infrastructure investments in roads and railways subsectors can be drawn. In Tables 5 and 6, there are summary results from roads and railways subsectors short run impact on economic growth modeling plus either roads or railways public infrastructure investments in constant USD per inhabitant indicator change from 1995 to 2016 and post-2009. Also, data availability limitations caused unequal time intervals (1990-2017 for short run impact modeling and 1995-2016 for public infrastructure investments in either roads or railways subsectors indicator).

Table 5. Roads subsector‘s impact on economic growth in short run and investments changes

Country code	**Roads impact**	**Overall change**	**Post-2009 change**	**Country code**	**Roads impact**	**Overall change**	**Post-2009 change**
AUT	None	-	-	HUN	+	+	-
BEL	None	+	+	IRL	+	N/A	N/A
BGR	None	N/A	+	ITA	None	-	-
CZE	None	+	-	LTU	+	+	-
DEU	N/A	-	-	LUX	+	N/A	N/A
DNK	+	+	+	LVA	+	+	+
ESP	+	-	-	NLD	None	N/A	N/A
EST	+	+	+	POL	+	+	-
FIN	+	+	+	PRT	None	N/A	N/A
FRA	+	-	-	ROU	+	+	-
GBR	+	-	+	SVK	None	+	+
GRC	None	N/A	+	SVN	+	-	-
HRV	+	+	-	SWE	+	+	+

Source: Author's research

As it can be seen from Table 5, post-2009 public infrastructure investments in roads subsector changes do not match the short run modeling results, because it seems that 'roads impact' and 'post-2009 change' columns signs pairs are distributed totally random. When comparing short run results with ‘overall change’, more matches between ‘roads impact’ and ‘overall change’ columns were found. However, negative overall public infrastructure investments in roads subsector change cases were distributed randomly.

Almost the same insights about situation in railways subsector, which results are given in Table 6, can be made. There is no strong relation between railways subsector’s impact on economic growth and public infrastructure investments in railways subsector post-2009 change, but both positive signs matches were found between ‘railways impact’ and ‘overall change’ columns with randomly spread negative signs ‘overall change’ cases.

Table 6. Railways subsector impact on economic growth in short run

Country code	Railways impact	Overall change	Post-2009 change	Country code	Railways impact	Overall change	Post-2009 change
AUT	+	+	-	HUN	+	+	-
BEL	+	-	-	IRL	None	N/A	N/A
BGR	+	+	+	ITA	+	+	-
CZE	+	+	-	LTU	+	+	+
DEU	None	-	+	LUX	None	N/A	N/A
DNK	+	+	+	LVA	+	+	-
ESP	+	+	-	NLD	+	N/A	N/A
EST	+	+	-	POL	+	-	-
FIN	+	+	+	PRT	+	-	-
FRA	+	+	+	ROU	+	+	+
GBR	None	+	+	SVK	None	+	-
GRC	+	N/A	-	SVN	+	N/A	+
HRV	+	+	-	SWE	+	-	-

Source: Author’s research

5. Conclusion

The main limitation of this research is that some analyzed models have nonnormal residuals. The initial sample size is 28, or 27 observations for the first differenced data. It is up to the reader to decide if large sample, or asymptotic, properties could be applied in this case. Otherwise, results of models with nonnormal residuals cases should be treated carefully.

Despite this limitation, several conclusions from this article‘s empirical research can be drawn. First of all, the chosen proxy variables for roads and railways subsectors were the one of physical infrastructure measures type, as it is common in other scientists empirical researches, but they also encompassed such feature like, in this article‘s case, roads or railways subsectors infrastructure usage ratio. Second, after econometric modeling any long run, either roads or railways subsectors impact on economic growth was not found. However, when modelling short run impact, overall statistically positive roads and railways subsectors impact on economic growth was found. Results in both cases were quite the same, with overall elasticity coefficients ranging in [0.06;0.52] interval with the average value of 0.23 in both subsectors. Third, it was tried to examine, if latest trends in public infrastructure investments in roads and railways subsectors have something in common with this article‘s empirical research results. It was found, that roads or railways subsectors impact on economic growth does not reflect public infrastructure investments in these transport infrastructure subsectors decreasing trend post-2009, but has something in common when comparing with overall investments situation from 1995 to 2016. At last it should be pointed, that the fact that either roads and railways infrastructure still has positive impact on economic growth in the European Union means, that up to this point, overall infrastructure in those transport subsectors is in the good shape. The post-2009 declining public infrastructure investments in either roads or railways subsectors pattern seems to be dangerous at first, but due to the facts that the European Union already has fully developed roads and railways infrastructure and overall investments are still a little bit above the 1995 level, at least for now there is still no big need to worry about the public roads and railways infrastructure investments trends.

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Appendix

Table A1. Countries codes

Country code	Country	Country code	Country
AUT	Austria	HUN	Hungary
BEL	Belgium	IRL	Ireland
BGR	Bulgaria	ITA	Italy
CYP	Cyprus	LTU	Lithuania
CZE	Czech Republic	LUX	Luxembourg
DEU	Germany	LVA	Latvia
DNK	Denmark	MLT	Malta
ESP	Spain	NLD	Netherlands
EST	Estonia	POL	Poland
FIN	Finland	PRT	Portugal
FRA	France	ROU	Romania
GBR	Great Britain	SVK	Slovakia
GRC	Greece	SVN	Slovenia
HRV	Croatia	SWE	Sweden