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INFRASTRUCTURE AS A FACTOR OF COMPETITIVENESS OF THE SELECTED EUROPEAN COUNTRIES

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Abstract

The paper examines the intensity of the infrastructure impact (roads, port infrastructure, air transport, electricity supply) on improving competitiveness quantified by Gross Domestic Product per capita (GDP pc) of twelve Emerging and Developing European countries according to the Global Competitiveness Index (GCI) of the World Economic Forum (WEF) and the methodology for the period 2007 - 2017. The impact of infrastructure as one of the basic factors of competitiveness on GDP growth per capita was seen through single (linear and exponential) and panel data linear regression analyses. The results of the research showed that the development of the infrastructure has a very positive impact on GDP growth per capita. Positive interdependence is far more evident in six economically less developed Emerging and developing European countries that were (Croatia) or are the current members of CEFTA (Albania, Bosnia and Herzegovina, Macedonia, Montenegro and Serbia) in comparison to the six remaining Emerging and developing European countries (Bulgaria, Hungary, Lithuania, Poland, Romania and Turkey) in the observed period. Taking into consideration the fact that all CEFTA countries analyzed are at some stage of their accession to the European Union, the conclusion is that they must pay special attention to the development of infrastructure.

Key words: infrastructure, competitiveness, economic growth, Emerging and Developing Europe, CEFTA.

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ИНФРАСТРУКТУРА КАО ФАКТОР КОНКУРЕНТНОСТИ ОДАБРАНИХ ЗЕМАЉА ЕВРОПЕ

Апстракт

У раду је испитиван интензитет утицаја развоја инфраструктуре (путева, лучке инфраструктуре, авио-транспортног саобраћаја, снабдевања електричном енергијом) на унапређење конкурентности дванаест европских земаља у развоју (Emerging and Developing European, EDE, по методологији Међународног монетарног фонда), у периоду 2012–2017. Притом су анализиране европске земље у развоју разврстане у две групе од по шест земаља: земље актуелне чланице CEFTA групације (Албанија, Босна и Херцеговина, Хрватска – која је до 1. 7. 2013. била чланица CEFTA, Македонија, Црна Гора и Србија) и шест осталих европских земаља у развоју (Бугарска, Мађарска, Литванија, Пољска, Румунија и Турска). Утицај инфраструктуре, као једног од базичних фактора конкурентности на раст бруто домаћег производа по становнику, истраживан је путем једноструке (линеарне и експоненцијалне) и помоћу панел-дата линеарне регресионе анализе. Резултати истраживања показали су да је ниво развијености инфраструктуре у периоду 2007–2012. имао изразито позитиван утицај на раст бруто домаћег производа по становнику у раду свих дванаест анализираних европских земаља. Позитивна међузависност је далеко израженија код шест земаља које су некад биле чланице CEFTA групације или су њене актуелне чланице. Узевши у обзир чињеницу да се све анализиране земље CEFTA налазе у некој фази свог придруживања Европској унији, закључак је да би оне посебну пажњу у наредном периоду морале да посвете развоју инфраструктуре.

Кључне речи: инфраструктура, конкурентност, економски раст, европске земље у развоју, CEFTA.

INTRODUCTION

The level of competitiveness of the country shows its ability to produce goods whose realization increases the level of well-being of the population in conditions of free competition. Therefore, considerable attention is paid to testing and improving competitiveness as one of the key strategic tasks of each country.

There is no generally accepted definition of the country's competitiveness. Moreover, the authors' views on the nature of the concept itself differ greatly in economic science. For instance, a number of economic theorists believe that the category of competitiveness has the status of the "natural law of a modern market economy" (Kitson et al., 2004). As evidence of such claims, these authors cite the fact that the policy of improving competitiveness has become one of the most important levers of economic development in recent years in many countries (USA, UK, Belgium, Italy, the Netherlands, and Japan). On the contrary, the number of economic analysts that consider the concept of competitiveness of the country as absolutely wrong and that it simply comes down to productivity, cannot be neglected (Krugman, 1994).

According to the definition of the World Economic Forum, competitiveness is a set of institutions, policies and factors that determine the

level of productivity of a country (Schwab & Porter, 2007; 2008) The country's competitiveness is theoretically more controversial in terms of competitiveness of enterprises (Commission of the European Communities, 2003) despite the fact that its promotion is often regarded as the main goal of economic policy. It is a general view that progress in the economic performance of the country does not have to be dependent on others and that factor productivity is a key element of competitiveness seen at a macro level (Cvetanović et al., 2015).

Since the country's competitiveness category is complex and comprehensive, the process of quantifying it is also very complex. The quantification of the increasing influence of non-price factors of international competitiveness, mainly of a qualitative nature, is one of the basic conceptual difficulties in showing the achieved level of competitiveness of countries.

Leaving aside the discussion on how to quantify the country's competitiveness, the view that the least controversial way of measuring the competitiveness of a country, which boils down to productivity, seems to be acceptable. This is due to the fact that the most important goal of a country is to provide its citizens with a high standard of living and its continued growth. The ability to do this depends on the productivity with which a working country and capital are used in a given country. Productivity is the main determinant of long-term living standards in one country, and the main determinant of gross domestic product per capita (GDP pc). "Productivity of human resources determines earnings of employees; the productivity of capital use determines the yield that it brings to its owners " (Porter, 2008, p. 165).

A particularly sensitive issue in theory relates to the drivers of the competitiveness of countries. Numerous factors influence the growth of economic prosperity, that is, the competitiveness of countries. The Institute for Management Development (IMD), the World Competitiveness Center from Switzerland, gives a list of even 200 factors (https://worldcompetitiveness.imd.org/). It is clear that competitiveness factors can be grouped according to different criteria. Among other things, it is possible to distinguish the inherited, on one hand, and created factors of competitiveness of the country, on the other (Ketels, 2006). For the competitiveness of the country, the factors that trigger activities that create value for customers are crucial. In principle, these are the created factors of competitiveness (Cvetanović & Mladenović, 2018).

All factors of competitiveness of the countries, according to the methodology of the World Economic Forum, can be grouped into twelve groups (Institutions, Infrastructure, Macroeconomic Environment, Health and Primary Education, Higher Education and Training, Goods Market Efficiency, Labor Market Efficiency, Financial Market Development, Technological Readiness, Market Size, Business Sophistication and Innovation). These pillars include microeconomic and macroeconomic factors

that, together with the institutions, determine the competitiveness of the country.

An important factor of the country's competitiveness is the infrastructure (Palei, 2015; Farhadi, 2015). Developed infrastructure reduces the effects of distance between individual regions, resulting in the integration of national markets and linkages with other countries with relatively low costs. Developed transport and communication infrastructure network is the prerequisite for connecting companies from less developed communities with economic entities of economically developed countries.

The subject of this work is infrastructure as a factor of competitiveness. There seems to be an attempt to see its significance for improving the competitiveness of countries measured by the growth of national productivity determined by GDP pc. (Estache & Garsous, 2012; Frone & Frone, 2014; Pradhan & Bagchi, 2013; Song & Geenhuizen, 2014; Cvetanović, Zlatković & Cvetanović, 2011). The aim of the research is to analyze the importance of infrastructure as a factor of competitiveness measured by GDP pc of twelve European countries belonging to the Emerging market and developing economies according to the methodology of the International Monetary Fund. This group includes the Republic of Serbia and all border countries. In addition to this group of countries, IMF World Economic Outlook also distinguishes Advanced economies (World Economic Outlook Database April 2017 -- WEO Groups and Aggregates Information, n.d.). This classification is not based on strict economic or other criteria, but it has evolved over time to facilitate the organization and analysis of significant economic data. The underlying hypothesis of work is that the development of the infrastructure has a positive impact on the improvement of the country's competitiveness.

The work is structured in seven sections. The first section is an introduction explaining the object and objectives of the research. The second section presents an overview of the theoretical empirical literature observing infrastructure and economic growth. In the third section, infrastructure is considered as the basic factor of competitiveness of countries. The fourth section describes the research methodology. The results of the research and discussion are given in the fifth section of the paper. The most important conclusions are systematized in the sixth section. Finally, in the seventh section, a list of the literature used is presented.

INFRASTRUCTURE AND ECONOMIC GROWTH: AN OVERVIEW OF THEORETICAL AND EMPIRICAL RESEARCH

The contribution of the infrastructure to the growth of the competitiveness of countries was studied in much of the theoretical literature. There are numerous models in which the place of individual forms of infrastructure, and especially public infrastructure, is explored, to improve

the competitiveness of countries quantified by productivity growth at the national level, i.e. the rate of economic growth (Barro, 1990; Glomm & Ravikumar, 1997; Ghosh & Roy, 2004). In a number of papers, the location of infrastructure as a component of physical capital in models of economic growth was examined (Cvetanovic et al, 2011) or the contribution of infrastructure to the developmental convergence of countries was studied (Cvetanovic et al, 2012).

Starting with the publication of Aschauer's works (1989a; 1989b), there has been an increasing number of empirical studies of the relationship between infrastructure and economic growth (Canning & Pedroni, 1999; Bougheas et al., 2000; Roller & Waverman, 2001; Calderón, C., & Servén, 2004; Calderón et al., 2015). In spite of the different methodological approaches and the use of different datasets, most empirical studies have confirmed the positive impact of infrastructure development on national productivity (Munnell, 1990; Fernald, 1999; Calderón, C., & Servén, 2004; Fedderke et al., 2006; Torrisi, 2010).

Hall and Jones (1999) tried to measure how many differences in the amount of physical capital contribute to the difference in output per worker between countries. Penn World Tables used data on physical capital. They compiled their results by comparing the five richest and the five poorest countries in their sample. The average product per worker in the group of rich countries was 31.7 times higher than the one in the group of poor countries. Even one sixth of the gap in the size of production per worker between the two groups of the observed countries was the result of differences in the amount of physical capital. Easterly and Levine (2002) also found that part of the differences in growth rates and GDP pc levels between countries can be explained by differences in the amount of capital.

There is a widespread consensus that infrastructure is necessary for economic growth and improving the competitiveness of countries. It is visible that infrastructure increases productivity and attracts business by reducing transport costs (Cvetanović et al, 2012) and production, as well as facilitating access to the market. Banerjee et al. (2012), Boopen (2006), kao i Torero et al. (2002) confirmed in their researches a positive causal link between the development of telecommunication infrastructure and economic growth in developing countries. Canning & Pedroni (2004) have proven that infrastructure has a positive impact on the long-term growth rate of GDP per capita. Also, they found great differences in the intensity of the infrastructure's impact on GDP growth in some countries. Duggal et al. (2007) conclude that public infrastructure has the potential to generate effects of economies of scale, which ceteris paribus leads to a continuous intensification of economic growth. Apart from being one of the most important drivers of economic growth, efficient public infrastructure improves quality of life and is crucial for national security

(Baldwin & Dixon, 2008). Therefore, it is logical that the improvement of the quality of infrastructure is an increasingly important goal of sustainable development policies for most countries.

Egert, Kozluk & Sutherland (2009) have identified the positive impact of investment in infrastructure on economic growth, indicating that this effect varies across OECD countries. Palei (2015) argues that infrastructure such as roads, electricity, telecommunication networks, water supply and waste management provides services that are crucial for the functioning of a modern economy.

Furthermore, in the works related to India and China (Sahoo & Dash, 2009; Sahoo, Dash & Nataraj, 2010), the analysis of the impact of investments in infrastructure on economic growth shows that there is a causal link between the development of infrastructure and economic growth. The authors conclude that from a policy perspective, more emphasis should be placed on infrastructure development in order to maintain the high economic growth that the Indian economy had in the years of the first decade of this century. In this context, the authors cite an example of China's aggressive investment (about 15% of GDP) in infrastructure explaining the maintenance of extremely high economic growth rates in China and minimizing the impact of the global financial crisis on its economy.

However, the authors of the paper which has a greater relevance for the research in this paper (Crescenzi & Rodríguez-Pose, 2012), as far as the EU is concerned, through panel analysis, come up with results showing that investments in transport infrastructure hardly predict the economic growth of some of the EU region. This is particularly worrying because of the fact that it has a significant role in EU regional development strategies.

On the other hand, the authors explore the impact of the three infrastructure components on economic growth (IT, energy infrastructure and roads and railways) in the case of the EU as a whole, in the paper The Effects of Infrastructure Determinants on Economic Growth: European Union Sample (Sahin, Can & Demirbas, 2014) 27, and especially the EU 15 and the EU 12. It is shown that investments in IT infrastructure have positive effects on economic growth in all groups, investments in energy infrastructure have positive effects in EU 15 and EU 27, and investments in rail and road infrastructure have positive effects only for the totally observed group of EU-27 countries.

The meta-analysis of the Infrastructure Impact Study on Economic Growth (Elburz, Nijkamp, & Pels, 2017) shows that the type of infrastructure, the research methodology, the time period, the type of infrastructure measures and the geographical extent of the research, affect the results of the primary studies that were processed. Studies suggesting interregional and inter-state relations have shown greater chances of finding

even the statistically negative effects of infrastructure on economic growth, giving authors an incentive for ideas about the effects of spillover of these infrastructure investments (Spillover Effect). Also, this meta-analysis shows that the choice of only some of the infrastructure characteristics, i.e. indicators from the exogenous side, as well as the selection of a particular economic sector from an endogenous foreign model most often does not have an effect on obtaining statistically positive, negative or irrelevant findings. These studies offer new findings on variations in empirical results in relation to modeling and analyzing the relationship between infrastructure and economic growth, which assumes a recommendation for the parallel application of several statistical techniques and tools for the credibility of the results obtained.

INFRASTRUCTURE AS THE BASIC FACTOR OF COMPETITIVENESS

It can be said that there is no consensus among researchers concerning which indicators characterize infrastructures in a sufficiently representative way as one of the factors for improving the competitiveness of countries. Most often, infrastructure is viewed as a coherent and unique set of interconnected elements, e.g. passenger and freight transport, water supply and sewerage, information and communication technologies (ICT) and energy transport (electricity, gas pipeline network) (Agenor & Moreno-Dodson, 2006). It is possible to observe the influence of each part of the infra structure on economic growth, or improving the competitiveness of individual countries (Canning & Pedroni, 1999).

When selecting indicators that represent the achieved level of infrastructure development, most commonly used physical indicators (kilometers of paved roads, length of railroads, number of airports, number of telephone lines, number of mobile subscribers, number of broadband Internet users), or, rarely, financial indicators (investment in development of infrastructure, investment in maintenance of infrastructure). It should be noted that the use of financial parameters must take into account: very complex estimates of the value of the existing infrastructure as a type of acquired social capital; differences in the life cycle of different types of infrastructure, as well as the specificity of investment and current costs, depending on the type of infrastructure. Due to the complexity of the monitoring of the effectuation of infrastructure investments, we believe that the use of physical indicators better reflects investments in infrastructure than financial parameters.

The most widely used method of measuring competitiveness of countries is the Global Competitiveness Index of the World Economic Forum. It is structured through 12 major drivers of competitiveness. (Figture 1).

Figure 1. Structure of the Global Competitiveness Index according to the GCI v3.0 methodology

Source: Despotovic, Filipović & Ilić, 2016, p.10 modified by WEF, 2018, p.9

The Global Competitiveness Index looks at the competitiveness of countries by factors determining the productivity category, which is considered the most important of its illustrations. The causal link between the category of competitiveness of the country and productivity is firmly grounded in theoretical and empirical research.

Each of the mentioned drivers (pillars) is in itself a composite index that is formed as a weighted average of the indicators. The pillar composition Infrastructure consists of the nine components presented in Figure 2.

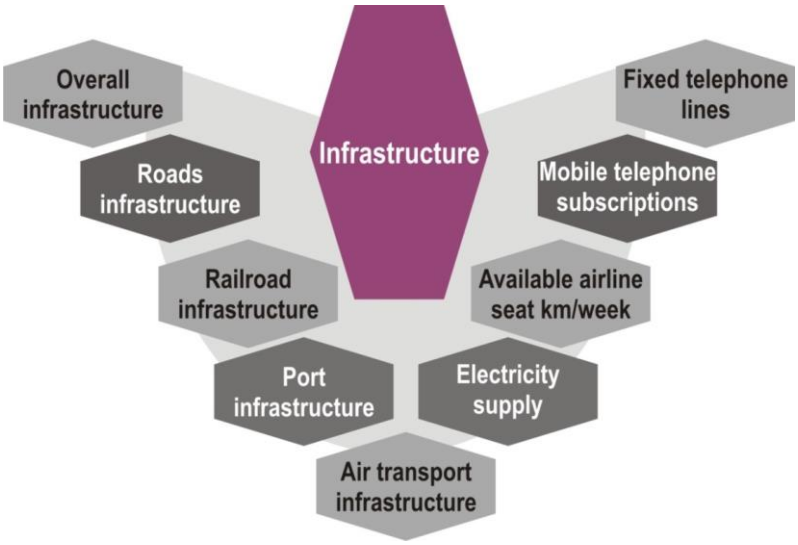

Figure 2. Components of Infrastructure as a GCI column

Developed and efficient infrastructure is the basis of competitiveness. Quality infrastructure promotes economic growth, and at the same time it reduces inequality in the distribution of created income and wealth. An efficient way of transporting goods, people and services, such as good roads, railways, ports, air transport, enables entrepreneurs to place their goods and services on the market. Economies greatly depend on good electricity supply as well as on the telecommunication network.

METHODOLOGY

In accordance with the research subject, in order to perceive the importance of well-developed infrastructure as one of the basic factors of competitiveness (according to the IGK methodology v3.0), productivity growth was measured at the level of GDP pc (which is considered the most important determinant of long-term economic growth) and the impact of Infrastructure pillar on the economic growth of the EDE countries (emerging and developing Europe country according to the IMF methodology) was analyzed.

The choice of the EDE (a group of fast growing European economies in development) is in line with the fact that it is a group of economies with similar economic and historical backgrounds that, at least in a part of the observed period, based their economic competitiveness on basic economic factors (*Basic Economic Requirements*) including infrastructure (WEF, 2018, p. 12).

Additionally, the division of ***Emerging and developing Europe (EDE)***[1] countries into two subgroups according to the CEFTA (Central European Free Trade Agreement) countries during the survey period (2007-2017) was carried out.

- CEFTA[2] countries (Albania, Bosnia and Herzegovina, Croatia, Kosovo as UMNIK, Macedonia, Montenegro and Serbia) and
- the remaining European countries of the non-CEFTA EDE (Bulgaria, Hungary, Lithuania, Poland, Romania and Turkey).

CEFTA membership is a mechanism for incubating potential EU members (except in the case of Turkey that is not a member of CEFTA but is a potential EU member) for full accession. The author's assumption is that the significance of the infrastructure's impact on growth in this group of countries can substantially bounce off the rest of the EDE countries (EDE non-CEFTA).

Based on GCI *data base* the development of the infra structure *is observed*, with one, and the GDP pc of the observed groups of countries, on the other hand, for the selected time period from 2007 to 2017 (that is, the maximum available time series according to World Development Indicators. n.d). The following two hypotheses are set:

H1 – The level of infrastructure development has a positive impact on the improvement of the competitiveness of countries expressed in GDP pc.

H2 – The significance of the positive impact of infrastructure development is inversely proportional to the achieved GDP pc of some countries.

H1 hypothesis is based on the assumption that raising the achieved level of infrastructure development promotes economic activities both internally within the economy and external with external economic entities within the region and the global economy. Therefore, it is expected that the change in the level of infrastructure development at the national level has a positive impact on the GDP pc, that is, the growth of the country's competitiveness. Additional support for the hypothesis H1 is given through the monitoring of data of achieved infrastructure level over time in relation to GDP pc, which is the incubation period for activating the observed impact of the hypothetically independent variable *Infrastructure* on the dependent variable *GDP pc*.

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[1] Lithuania was taken because it belonged to the EDE group by the end of 2014 according to the Select Aggregates IMF WEO. (ND), which coincides with the end of the observed time series (since 2015, Lithuania does not belong to the EDE group)

[2] CEFTA agreement: Croatia (2003-2013), Macedonia (2006-), Albania (2007-), Bosnia and Herzegovina (2007-), Montenegro (2007-), Serbia (2007-). Kosovo as UNMIK (2007-).** Croatia has not been a member of CEFTA since 2013, but it has been a major part of the observed time series; *** Kosovo as UMNIK is not included due to inaccessible data for most of the observed time series.

The H2 hypothesis is based on the fact that Infrastructure is one of the basic factors of competitiveness of countries and its direct positive impact decreases in proportion to GDP growth pc. The high level of infrastructure development is an immanent characteristic of economically developed economies that base their economic development on the innovative performances of market entities as the global paradigm of future economic progress.

The starting methodological assumptions in this research are as follows:

1. In addition to descriptive statistics, the methodology of the research implies the application of single regression analysis and panel data regression analysis, which checks the level of credibility of the obtained results (since previous research of these phenomena resulted in contradictory results).
2. The assumed research model has a simple structure with as few variables as possible and with the maximum available time series of data. Variables in the model are the abstracted scalar values of multidimensional phenomena: a) Pillar Infrastructure GCI and b) Economic Growth. In this way, on the one hand, the granulation of the model is lost, but, on the other hand, it is easier to interpret the obtained results and define general recommendations.
3. The observed population in the model is defined and observed: a) at the level of the selected 12 EDE countries; and b) at the level of groups of six countries (EDE CEFTA and EDE non CEFTA countries) assuming the different potential of the impact of infrastructure on the economic growth of the countries measured by GDP pc. This is directed towards reducing the impact of the spillover effect (which exists between the countries that make up these two groups) on the obtained results of the research.

The process of data preparation and statistical analysis in the research was carried out in three steps.

i) analyzing the database of the reference GCI reference frame for identifying the tested variables, as well as downloading, filtering and structuring available data (Competitiveness rankings, n.d.),
ii) a statistical check of the time series of data in order to determine their degree of homogeneity and consistency (descriptive statistics) that are graphically represented in the box plot diagrams
iii) application of statistical tools: a) simple (linear and exponential) correlation and regression analysis; b) panel linear regression analysis (with fixed and random effects) for exploring interdependence of infrastructure and economic growth according to the assumed hypothetical model.

RESULT RESEARCH AND DISCUSSION

Infrastructure Impacts on the Competitiveness of Countries Valued for GDP pc were examined on a sample of 12 EDE countries, which were observed:

- as a unique EDE group that encompasses all 12 countries and as two subgroups in line with CEFTA membership during the observed period (2007-2017);
- EDE CEFTA subgroup consists of 6 countries that have been CEFTA members for most of the observed period
- EDE non-CEFTA subgroup consists of 6 non-CEFTA countries during the observed period.

Descriptive Statistics

Figure 2 shows the average values: a) Pillar GCI - Infrastructure and b) GDP per capita and current US dollars for each of the analyzed countries in the observed period. The diagram at the level of average values shows that there is a potential positive relationship between the observed variables that we will examine in detail in the following part of the work.

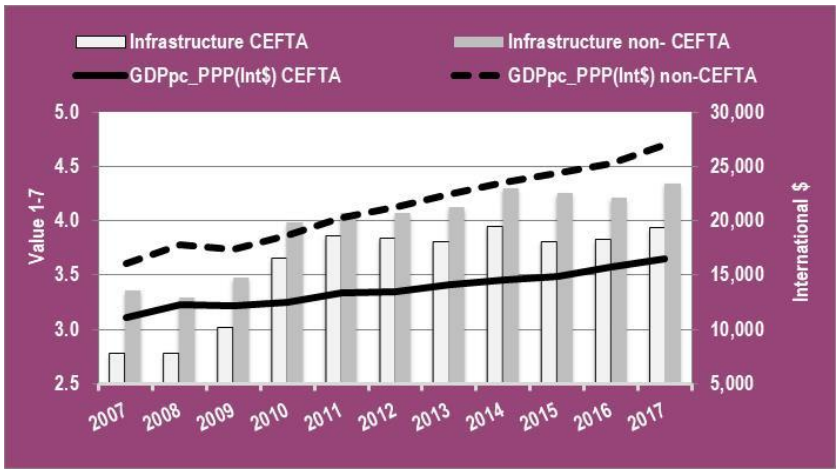

Figure 3. Average values of analyzed variables in the period 2007-2017.
Source: Downloads GCI dataset in Excel. (n.d.); World Development Indicators. (n.d.)

Figure 3 illustrates infrastructure trends and GDP per capita in the period 2007-2017. CEFTA countries, as well as other non-CEFTA EDE countries, are viewed as unique entities, allowing for a simple comparison of the level of infrastructure development in them as well as the achieved GDP pc level. Observed characteristics by selected groups of countries are shown aggregately as the average of the results achieved by the ob-

served countries in the domain of infrastructure development (according to GCI) and by competitiveness quantified by GDP pc.

Based on Figure 3, it is noticed that there is a constant improvement in the achieved level of infrastructure in both observed EDE countries, but with the fact that the evident advantage of the non-CEFTA group has significantly decreased since 2010. GDP per capita in both groups of countries shows the obvious effects of the economic downturn with double bottom.

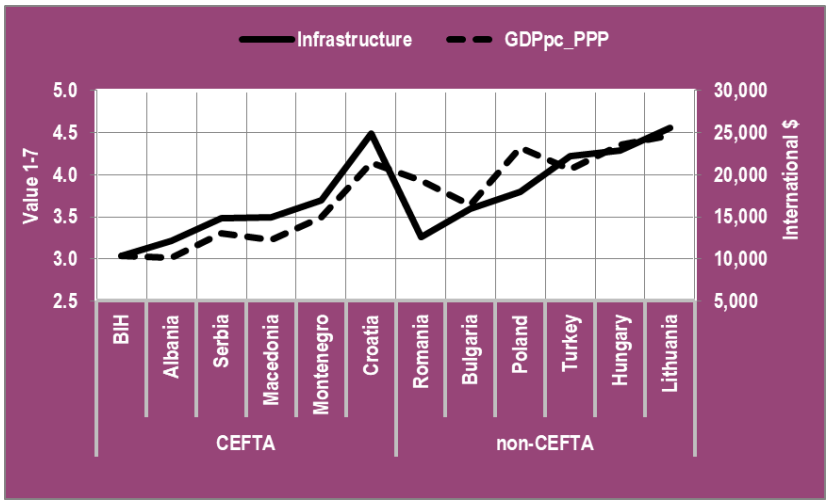

Figure 4. Infrastructure movement and GDP pc for CEFTA and non-CEFTA countries

Source: Downloads GCI dataset in Excel. (n.d.); World Development Indicators. (n.d.)

In Figure 4, it can be seen that Croatia, according to the average values of both indicators, is most developed within CEFTA, and Lithuania within the non-CEFTA group of countries.

In Figure 5, mean values, standard deviations, and variation coefficients of analyzed variables in the model (x and y) for all three population sets are given. Also, the box plot diagram of the observed variables is shown.

Infrastructure variable			
Variables	EDE	EDE CEFTA	EDE non-CEFTA
Mean velue	3.76	3.57	3.95
Standard deviation	0.66	0.67	0.61
Coefficient of variation	18%	19%	15%

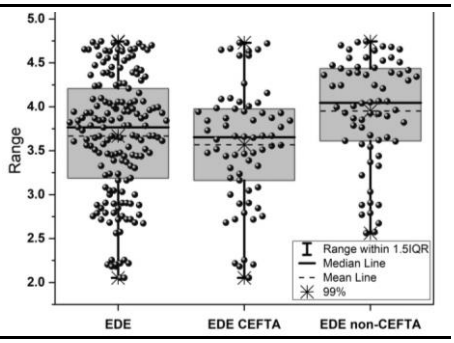

Figure 5. Summary statistics of Infrastructure variable for the period 2007 to 2017
Source: Downloads GCI dataset in Excel. (n.d.)

GDP per capita variable			
Variables	EDE	EDE CEFTA	EDE non-CEFTA
Mean velue	17,483	13,688	21,277
Standard deviation	5,785	4,166	4,566
Coefficient of variation	33%	30%	21%

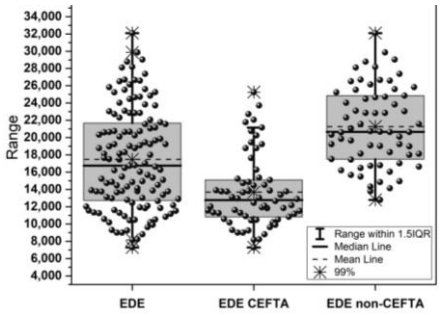

Figure 6. Summary statistics of GDP per capita variable for the period 2007 – 2017
Source: World Development Indicators. (n.d.)

Based on Figures 5 and 6, it is possible to formulate the following conclusions:

- the presence of atypical values is noticed due to the highly positive or negative deviation of the elements relative to the rest of the population with the exception of the GDP per capita variable for the CEFTA population, where data for Croatia show atypical high values,
- the average values as well as the quartile and median values of the observed variables included in the analysis show that the data are comparable and relatively homogeneous in all observed population aggregates.

The relatively low variation coefficients of an independent variable (x - infrastructure) in the model indicate that this is a variable where the share of the forest is statistically low, which confirms the accuracy of the behavior prediction in the initial model. The significantly higher coefficient of variation shows the dependent variable (y - GDP per capita), which is expected due to its complex character.

Because of the fact that the research is based on regression analysis, it is also necessary to prove the absence of a unit root, that is, the temporal stationarity of the observed variables in the model. If this condition is not met, false regression can occur and the estimated parameters could be biased (Levin, Lin, & Chu, 2002). As the independent variable Infrastructure in the model represents the aggregated value of the 2nd pillar GCI, it is assumed that this variable is inherently relative and time stationary. The dependent variable GDP pc as well as most of the standard econometric indicators may tend to be unstable. To test the stationarity of the data panel in the model, a Levin-Lin-Chu unit-root test was applied, and the results were given in Table 1.

Table 1. Unit-root test for variables in model

Number of panels = 12	Number of periods = 11			
Variable	X1	Y	Y′	Ln(Y)
Levin-Lin-Chu unit-root test Ho: Panels contain unit roots Ha: Panels are stationary				
p-value	0.0000	0.6902	0.0024	0.0049
Unadjusted t statistic	-13.277	-0.671	-7.448	-3.345
Adjusted t* statistic	-11.829	0.497	-2.815	-2.582

X1 – *Infrastructure;* Y – *GDP pc PPP (international $)*

Table 1 presents the results of the applied test of the existence of a single root of the analyzed data panels. As shown in Table 1, the null hypothesis of the existence of a unit root can be rejected for an independent *Infrastructure* variable (p-value <0.05), indicating its stationarity. On the other hand, the applied root test concludes that the dependent variables Y (GDP pc) show a statistically significant tendency of non-stationarity. Therefore, the additional step of checking the stationarity a) of the natural logarithm of the dependent function Ln (Y) and b) of the first derivative of the dependent function Y '. Both transformed values of the dependent variable according to the applied test do not show the expressed tendency of the unit root of the time series.

Consequently, single linear / exponential regression analysis and panel regression analysis can be continued.

Single Regression Analysis

For the time series in the period 2007-2017, a corresponding regression model (linear and exponential regression) was constructed, with the 2nd pillar GCI - *Infrastructure*, which includes 9 indicators (shown in Figure 2), as an independent variable. It is a composite indicator because it represents the aggregated value of the corresponding infrastructure indicators. The movement of economic growth, as dependent variables, is monitored through *Gross domestic product per capita* and current US dollars.

The degree of interdependence of *Infrastructure* and GDP *per capita* (in US $) as a competitiveness indicator was examined through a single regression and correlation analysis using linear (1) and exponential (2) functional dependencies.

Linear: $y(t)= A + B*x(t-1)$ (1)

Exponential: $y(t) = B*e^{A*x(t-1)}$ that is $\ln y(t) = B + A*x(t-1)$ (2)

where:
a, b – constants of the linear/exponential model;
x – independent (exogenous) variable (infrastructure);
y – dependent (endogenous) variable (GDP per capita international US$);
t – time in years;

As shown in the equations, the design of the model took into account the time delay of the influence of the *infrastructure* on the GDP *per capita* movement, so that these two variables were taken with a time shift of one year (t = 1)

Based on the results of the conducted regression analysis presented in Tables 2 and 3, two models of linear and exponential form were obtained.

Table 2. Summary statistics of linear regression analysis

	Dependent variable: ***y(t)*** **–** GDPpc_ppp		
	(1)	(2)	(3)
x(t-1) - Infrastructure	6,333***	5,002***	5,150***
	(538.5)	(454.1)	(650.8)
Constant	-5,701***	-3,716**	1,644
	(2,037)	(1,632)	(2,578)
Observations	120	60	60
R^2	0.540	0.677	0.519
Adjusted R^2	0.536	0.671	0.511
Root mean square err	3942.1 (df = 118)	2355.5 (df = 58)	3073.8 (df = 58)
F Statistic	138.32	121.37	62.63

Note: *p<0.1; **p<0.05; ***p<0.01
(1)Emerging and Developing Europe (EDE) group; (2) CEFTA subgroup; (3) Non CEFTA subgroup

Table 3. Summary statistics of exponential regression analysis

	Dependent variable: **ln(y(t)) – Ln(**GDPpc_ppp)		
	(1)	(2)	(3)
x(t-1) - Infrastructure	0.372***	0.342***	0.243***
	(0.0306)	(0.0282)	(0.0299)
Constant	8.352***	8.297***	9.018***
	(0.116)	(0.101)	(0.119)
Observations	120	60	60
R^2	0.557	0.717	0.532
Adjusted R^2	0.553	0.712	0.524
Root mean square err	0.224 (df = 70)	0.146 (df = 58)	0.141
F Statistic	148.09	146.70	66.01

Note: *p<0.1; **p<0.05; ***p<0.01
(1) Emerging and Developing Europe (EDE) group; (2) CEFTA subgroup; (3) NonCEFTA subgroup

Graphic interpretation of the linear and exponential regression model of infrastructure influence, not economic growth, is shown in Figures 7, 8 and 9.

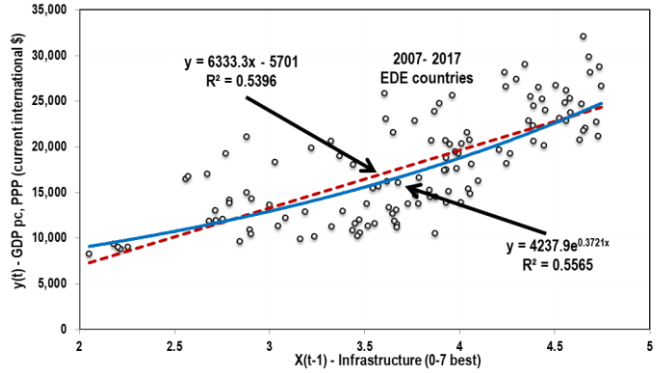

Figure 7. Dependence of GDP per capita from the level of infrastructure for all EDE countries

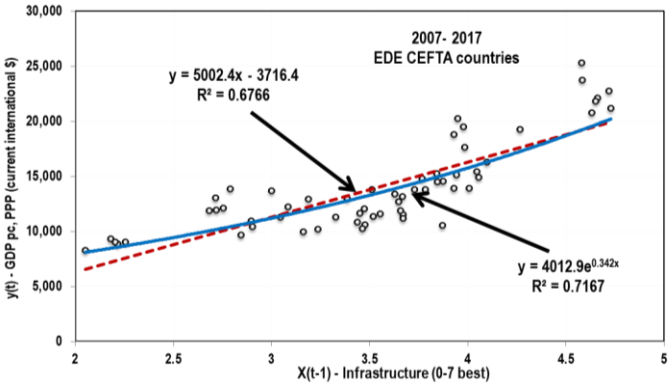

Figure 8. The dependence of GDP per capita on the level of infrastructure for EDE CEFTA subgroup of countries

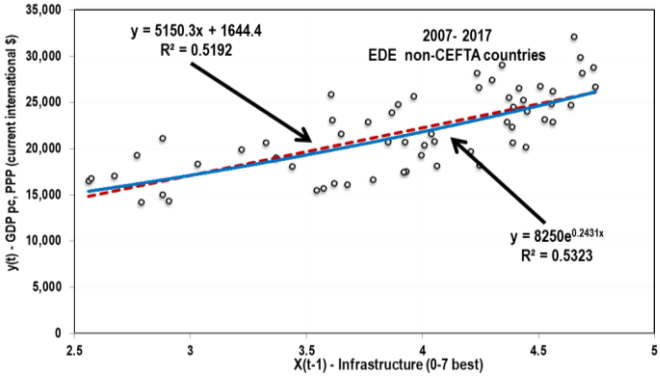

Figure 9. Dependence of GDP per capita from the level of infrastructure for EDE non-CEFTA subgroup of countries

(1) The analysis of the relationship shown in Figure 7 (Hypothesis H1) determined the Pearson correlation coefficient R = 0.746, which is more than the limit value that is 0.380 for the number of degrees of freedom n = 70 and the significance level p <0.01.
(2) The analysis of the relationship shown in Figure 8 (Hypothesis H2) determined the Pearson correlation coefficient value R = 0. 847, which is more than the limit value which is 0.525 for the number of degrees of freedom n = 34 and the significance level p <0.01
(3) The analysis of the relationship shown in Figure 9 (Hypothesis H2) determined the value of the Pearson correlation coefficient R = 0.730, which is more than the limit value which is 0.525 for the number of degrees of freedom n = 34 and the significance level p <0.01

Correlation coefficients unambiguously show that there is a significant degree of interdependence of the observed variables in all three observed populations, and that it is most evident in the population of the EDA CEFTA group of countries.

The results obtained indicate that:

(1) change in the achieved level of infrastructure development in the period 2007-2017 had a statistically significant impact on the competitiveness measured by the GDP pc of the countries of the EDE (p <0.01) and variations of this variable explain about 55% (the coefficient of determination R2 is 0.55 in the exponential and 0.54 in the linear model) of the total variations in the economic growth movement of the EDE countries in the period 2007-2017 on the assumption that the remaining 45% variation of GDP pc is under the influence of factors which are not covered by the model.

However, when further test iteration examines the results at the level of the two subgroups of countries within the EDE, it is shown that:

(2) Variations of independent variables explain as much as 71% (the coefficient of determination R2 is 0.71 in the exponential and 0.67 in the linear model) of the total variations in the economic growth movement of the countries of the EDA CEFTA in the period 2007-2017 assuming that the remaining 29% variation of GDP pc is under the influence of factors that are not covered by the model.
(3) Variations of variable Infrastructure explain only 53% (the coefficient of determination R2 is 0.53 in exponential and 0.51 in the linear model) of the total variations in the economic growth of non-CEFTA countries in the period 2007-2017 assuming that the remaining 47% of the GDP pc variation is under the influence of factors not covered by the model. This shows that for a group of non-CEFTA countries, the statistical significance of the impact of infrastructure on economic growth is considerably lower in both of the applied regression models.

This suggests that a certain potential of the connection between the default variables of the *Infrastructure* and the *GDP pc* exists, and that it is particularly evident in the EDE CEFTA group.

Panel Linear Regression Analysis

However, as far as the panel timeline is concerned, it is assumed that the obtained guidelines for the connection of the observed variables should be statistically analyzed by panel linear regression analysis. Panel analysis was done for each of the observed groups in particular (and not for the entire population of EDA countries) and a binary EUdummy variable was introduced, which has a value of one if the country was a full EU member in that year or zero in the opposite situation. The idea is that using this dummy variable will absorb the impact of EU membership on the GDP pc and thus isolate the impact inherent in the Infrastructure variables.

In general, Panel data linear regression analysis is performed as a statistical process for assessing the relationship between variables involving a time series aspect. This also involves the use of a predefined model and analysis of variables with a focus on the relationship between GDP pc, a representative of economic growth, and 1 independent variable *Infrastructure and one dummy variable*. Such Panel data multiple regression analysis helps us understand the process of change in the value of the dependent variable when the value of some of the independent variables varies, assuming *ceteris paribus*.

$$y_{it+n} = \alpha + x'_{it}\beta + c_i + u_{it} \tag{3}$$

Where: y_{it+n} is dependent variable, α is intercept, $x'it$ is a K-dimensional row vector of explanatory variables, β is K-dimensional column vector of parameters, ci is country specific effect and uit is error overall term.

The model is linear in parametersα, and β , individual effect ci and overall error uit.

In the random effect model, the individual-specific effect is a random variable that is uncorrelated with the explanatory variables. This assumption says that the individual-specific effect is a random variable that is uncorrelated with the explanatory variables of all past, current and future time periods of the same individual. At contrary, in the fixed effects model, the individual-specific effect is a random variable that is allowed to be correlated with the explanatory variables test. In order to decide between fixed or random effects we run a Hausman test where the null hypothesis is that the preferred model presents random effects vs. the alternative fixed effects (Torres-Reyna, 2007). It basically tests whether the unique errors uit are correlated with the regressors, the null hypothesis is they are not.

By applying multiple regression analysis with the so- a) random and b) a fixed effect, as well as checks of their adequacy by the realization of the Hausman test, we obtained the results shown in Table 4.

Table 4. Results of Multiple regression using fixed & random effect model and Housman test

Hausman test hypothesis	Probability of H0			
H0: difference in coefficients not systematic	Prob>chi2 = 0.0000		Prob>chi2 = 0.8372	
Group of countries	**EDA CEFTA countries**		**EDA non-CEFTA countries**	
Type of regression model	Random-effects GLS regression	**Fixed-effects (within) regression**	**Random-effects GLS regression**	Fixed-effects (within) regression
Variables	L.GDPpc_ppp	**L.GDPpc_ppp**	**L.GDPpc_ppp**	L.GDPpc_ppp
Infrastructure	2,881***	**2,109*** **	**5,715*** **	5,770***
	(387.3)	**(318.9)**	**(773.4)**	(825.0)
EUdummy	3,230***	**2,320*** **	**2,599**	-
	(839.9)	**(662.1)**	**(2,657)**	
Constant	2,681*	**5,554*** **	**-4,386**	-2,440
	(1,471)	**(1,168)**	**(4,095)**	(3,325)
Observations	60	**60**	**60**	60
Number of ID	6	**6**	**6**	6
R-squared: within	0.534	**0.534**	**0.480**	0.480
between	0.973	**0.973**	**0.621**	0.522
overall	0.776	**0.776**	**0.541**	0.493

GDP with lag of 1 year; Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Linear regression analysis over panel data, as well as the realized Hausman test, shows that the assumed multiplier regression model with a fixed effect best explains the impact of infrastructure on GDP pc at EDA CEFTA countries. Based on this, we can conclude that an adequate econometric model for this group of countries has a form:

$$\text{GDPpc\_ppp}_{it} = (\mathbf{2{,}109} \bullet \mathit{Infrastructure}_{it-1}) + (\mathbf{2{,}320} \bullet \mathit{EUdummy}_{it-1}) + \mathbf{5{,}554} + c_i + u_{it} \quad (4)$$

On the other hand, to explain the impact of infrastructure on GDP pc with the other observed group of so-called EDA non-CEFTA countries, the regression model with a random effect was shown to be more adequate and it has a form:

$$\text{GDPpc\_ppp}_{it} = (\mathbf{5{,}715} \bullet \mathit{Infrastructure}_{it-1}) + (\mathbf{2{,}599} \bullet \mathit{EUdummy}_{it-1}) - \mathbf{4{,}386} + c_i + u_{it} \quad (5)$$

The results presented are in line with the theoretical assertions and the H1 starting hypothesis that the level of development of the Infrastruc-

ture has a positive impact on the improvement of the competitiveness of the countries expressed in the GDP pc. Also, the importance of the model is significantly higher in the EDA CEFTA group of countries according to all three panel coefficients of determination R2 (within panels, between panels, overall) which is in line with the H2 hypothesis according to which the significance of the positive influence of the infrastructure development is inversely proportional to the achieved GDP pc of certain countries.

We can say that the overall results of the survey of the models placed on the observed sample of European developing countries confirm the potential of H1 and H2 hypothesis on the impact of the independent variable x (infrastructure) on the dependent variable y (GDP per capita). Based on the obtained values in the applied regression models (linear, exponential and panel), the conclusion is that the statistically significant and systematic impact of the infrastructure on economic growth can be expected especially at the lower stages of economic development of countries (in our case EDA CEFTA countries).

It is unambiguous that according to the results obtained, the infrastructure has a significant positive impact on the improvement of competitiveness measured by the achieved GDP pc of the observed group comprised of 12 EDE countries. However, as in the previously analyzed papers (Crescenzi, & Rodríguez-Pose, 2012; Elburz, Nijkamp & Pels, 2017) our results also show that there is a threshold to which a stronger impact of infrastructure investment on economic growth is possible (that is, to what level infrastructure and new infrastructure investments can be a catalyst for sustainable economic growth). Consequently, the non-CEFTA countries of the EDA can count on the lower potential of infrastructure investment in relation to the EDE CEFTA countries, which in Europe are the furthest from that infrastructure threshold. Therefore, for EDE CEFTA countries it is very important that their national and regional development strategies and structural adjustment policies accelerate investment in infrastructure. In support of this, there is a very important role of infrastructure development implemented in the current EU regional development strategies (including the CEFTA region as a future integral part of this economic union), as well as the current mega project of China called Silk Road that plans to invest significant funds in the development of infrastructure in the CEFTA countries (Tonchev, 2017).

CONCLUSION

Based on the results obtained from the previously analyzed model of the impact of *infrastructure* on economic growth, it is shown that in the less developed countries of the EDE CEFTA countries, *infrastructure* represents a significant factor in the country's competitiveness, unlike

other EDE non-CEFTA countries. The reason for this may be the fact that in non-CEFTA countries, achieved by the level of infrastructure, its potential for direct impact on growth of competitiveness is exhausted.

In order to better understand the impact of *infrastructure* on improving competitiveness of countries, further research could go towards further granulation of the survey taking into account the impact of the achieved level of individual indicators of the composite pillar of infrastructure on improving competitiveness quantified by GDP pc.

All this leads to the imperative of EDE CEFTA countries that economic growth must largely be based on accelerated development and efficient use of infrastructure. The basic message is that they have to devote far greater attention to their own infrastructure development strategies. This is a necessary condition for the increasing economic growth to improve their competitiveness based primarily on the mutual economic cooperation of the countries in the region, as well as in the entire region with a European and global environment. On this path, the experience of other EDE countries can be of great benefit (Western Balkan Summit 2017, n.d.).

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ИНФРАСТРУКТУРА КАО ФАКТОР КОНКУРЕНТНОСТИ ОДАБРАНИХ ЗЕМАЉА ЕВРОПЕ

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Резиме

Предмет истраживања у овом раду јесте инфраструктура као фактор конкурентности дванаест европских земаља у развоју (Emerging and Developing European, EDE, по методологији Међународног монетарног фонда), у периоду 2007–2017. Притом су анализиране EDE земље разврстане у две групе од по шест земаља: земље актуелне чланице CEFTA групације (Албанија, Босна и Херцеговина, Хрватска – која је до 1. 7. 2013. била чланица CEFTA, Македонија, Црна Гора и Србија) и шест осталих европских земаља у развоју (Бугарска, Мађарска, Литванија, Пољска, Румунија и Турска). Циљ истраживања је указивање на значај инфраструктуре за унапређење конкурентности сагледаваних земаља. Уважавајући чињеницу да је категорија конкурентности земље крајње комплексног карактера и да је њено квантификовање веома сложен процес, у раду се, на основу података из Глобалног индекса конкурентности Светског економског форума, истражује утицај инфраструктуре као једног од дванаест стубова конкурентности (развој: путничког и теретног транспорта; информационе и комуникационе технологије; транспорта енергената) на раст БДП по становнику. За ту сврху конструисан је модел међузависности инфраструктуре и привредног раста који је испитиван на узорцима од дванаест европских земаља у развоју, при чему је шест земаља које су у посматраном периоду биле чланице CEFTA и шест преосталих европских земаља у развоју. Поступак статистичке анализе овог утицаја спроведен је у три корака: а) анализом референтног фрејмворка Глобалног индекса конкурентности за идентификацију испитиваних варијабли, преузимањем, филтрирањем и структурирањем доступних података, б) статистичком провером временске серије података у циљу утврђивања њиховог степена хомогености и конзистентности, који су графички представљени бокс-плот дијаграмима и в) применом једноструке (линеарне и експоненцијалне), као и панел-регресионе, анализе за истраживање међузависности инфраструктуре и привредног раста. Добијени резултати показују да код земаља чланица CEFTA инфраструктура представља значајнији фактор унапређења конкурентности у односу на остале европске земље у развоју (EDA земље). Ово наводи на закључак да земље CEFTA групације морају да усмере напоре у правцу убрзаног развоја инфраструктуре не би ли значајније унапредиле властиту конкурентост.