The impact of the quality of transport networks on economic competitiveness in the European Union*

Cezar TECLEAN**

Abstract

This paper assesses the impact of transport infrastructure quality on economic competitiveness in the European Union (EU), context in which we argue that the quality of the different modal transport networks has a differentiated contribution on competitiveness. The purpose of our analysis aims to quantify the qualitative contribution of each modal transport network to economic competitiveness in the EU. The econometric quantification of the mentioned impact emphasizes a contributory hierarchy as follows: the quality of port and railroad infrastructure contributes most substantially to economic competitiveness, followed by the quality of the air transport infrastructure, the inland waterways and the road network. Based on the iterated results, we sequenced the EU member states with the lowest quality of networks with the highest impact on competitiveness. Thus, we identified the states for which the priority improvement of the quality of the port and railway infrastructures would significantly improve their economic competitiveness.

Keywords: transport infrastructure, sustainable quality, economic competitiveness, spatial competitiveness, European Union

Introduction

The concern of European governments and institutions to ensure sustainable growth in the European Union (EU) has led to the permanent focus of Union forums on improving economic competitiveness and its determinants. One of the catalytic premises of competitiveness is the quality of transport infrastructures from its position of simultaneous adjuvant factor of several dimensions of development, complementary to competitiveness: spatial accessibility, interregional connection, development of endogenous territorial potential, increase of territorial cohesion. This plurivalence of the quality of transport networks in relation to development and competitiveness, has made European decision-makers in recent years focus not only on the territorial expansion of transport infrastructures,

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** Cezar TECLEAN is associate researcher at International Economic Relations Research Center, Bucharest University of Economic Studies, Romania, e-mail: cezar10tc@yahoo.com.

but also on their quality (Mullen and Marsden, 2015, p. 2). According to the European Commission's Transport White Paper 2011, the European transport strategy aims to increase economic performance and improve competitiveness (Purwanto *et al.*, 2017, p. 2882) based on increasing the quality and capacity of transport networks by 2050 under efficient use of available resources (European Commission, 2011, p. 9).

Given the above imperatives, the contribution of transport infrastructure to increasing competitiveness is a very high stake in the EU (Annoni and Dijkstra, 2019, p. 20), which makes it essential to know to what extent the Union's competitiveness is sustainable based on the quality of transport networks. On the background of the quality gaps of the transport infrastructures within the EU, we support the hypothesis according to which the quality of the transport networks has a differentiated contribution by modes of transport on the economic competitiveness. Moreover, we show that the recent Brexit has also changed the contribution of different modes of transport to the competitiveness in the EU.

The overall purpose of our research aims to quantify the contribution of the quality of each modal transport network on the economic competitiveness in the Union space. For the quantitative assessment we use a gravitational econometric model consisting of a set of multiple regression equations that successively quantify the impact of the quality of each modal transport network on economic competitiveness in the EU. Quantitative knowledge of the relationship between the quality of the various modal transport components and economic competitiveness is relevant for prioritizing decisions to improve modal networks with the most significant impact on economic competitiveness.

Our study covers an unprocessed area in the literature, namely the comparative investigation of the behaviour of different modal transport networks in relation to economic competitiveness in the EU with and without Great Britain. On these coordinates, we design the concept of sustainable quality of transport networks to define the quality levels of these infrastructures from the perspective of their ability to sustainably sustain a certain level of economic competitiveness in the spaces they equip. Against this background, the original contribution and practical implications of our research are given by the identification of spaces equipped with insufficiently sustainable transport infrastructures in terms of quality in order to formulate intervention priorities to improve the quality of infrastructure components with maximum potential to improve economic competitiveness.

Our paper is structured modularly, starting with an introductory section followed by a review of the essential elements of the literature. The next section contains the methodology of the empirical research, continued with the presentation and discussion of the results obtained and finally the presentation of the concluding remarks.

1. The quality of transport networks as a premise of economic competitiveness

The implications of the quality of transport infrastructure in terms of economic competitiveness and further on the evolution of the entire European economy have led to an increase in scientific analysis of the relationship between the quantitative and qualitative development of transport networks and the dynamics of EU economic competitiveness. The different perspectives of the approach considerably extended the epistemological and conceptual area of the analysed field. Competitiveness is a concept specific to the integrated and globalized world influenced mainly by the four determinants of the Porter model ("Porter's Diamond": resource fund, business environment, related industries and domestic market demand) as the main factors (Porter, 1990), to which are added a number of other complementary factors, among which the quality of the transport networks remains the essential factor for generating accessibility and capitalizing on the regional potential (Chacon-Hurtado *et al.*, 2020), making good cross-border connections, reducing trade costs (Kurmanalieva, 2020, pp. 5, 10) and attracting capital investment (Cervero, 2009, p. 212). On this background, Feldman *et al.* (2008) explain that economic benefits come at the end of a value chain on the basis of which the parameters generating competitiveness (including transport networks) encourage competition which in turn delivers economic results. In this regard, Button (2003) shows that the link between the availability of transport infrastructure across the EU and economic development is a positive correlation which, according to Stough *et al.* (2002) and von Hirschhausen (2002) are the engine of competitive development, including for the less developed areas of the EU.

The idea of EU-wide competitiveness and the contribution of transport infrastructure quality to its realization is gaining a growing niche on the academic discourse agenda, given that the notion of competitiveness at national level still provokes heated debates from a conceptual and methodological point of view. Thus, Krugman (1994, pp. 28, 41; 1996, p. 17) disputes the thesis that a country's well-being depends on its competitiveness in international markets, but rather on the domestic productivity of labor and capital, which makes it more feasible to address the impact of the quality of transport networks on competitiveness rather at EU level as a whole. In this context, Greaves (2019, p. 35) and Mačiulis *et al.* (2009, p. 97) show that the quality of modal networks comes with the efficiency of green transport as a prerequisite for the sustainability of Community transport systems within the single European transport area. But the gradual fulfillment of these planned steps in stages by 2030 and 2050, respectively (European Commission, 2011, pp. 9, 17, 27), involves the allocation of significant financial resources to improve transportation systems (Laird and Venables, 2017, p. 2) as a condition for improving spatial competitiveness (Kiel *et al.*, 2014, p. 78). In an analysis of the return

on capital invested in transport infrastructure, Aschauer (1989, p. 197) argues that the most relevant infrastructure elements to sustain competitiveness are roads, ports and railways, a conclusion resulting from the application of the public capital analysis method of social rates of return and not the classic cost-benefit analysis. Without challenging the "core infrastructure" status that Aschauer assigns to the three modal infrastructures mentioned, we consider that by circumventing the cost-benefit analysis method, the possibility of economic-spatial evaluations through the parameter of transport costs is emaciated, an indicator to which Krugman (1991) assigns a key role in determining the configuration of space economies through the epistemic lens of the new economic geography.

The relationship between the quality of transport networks and competitiveness is one of the themes subsumed by the concept of sustainable development and from the perspective of the regional and local levels. Based on the cost-duration-quality analysis model, Wang *et al.* (2018, pp. 3, 18) show that the sustainability of transport is a key element of sustainable regional development through the multiple spillover effects in terms of space, economy and environment that transport networks induce at the regional level. However, Polyzos and Tsiotas (2020, p. 21) found that the major beneficial impact of transport infrastructure development at all levels (European, national, regional) can only be achieved through the simultaneous application of appropriate transport infrastructure policies. At the same time, the Cambridge Econometrics / Ecorys-NEI report (2005) for the European Commission highlights a number of issues that depend on the level of analysis and the mode of transport, showing that:

> *Every region has its own specific needs in terms of both overall scale of transport networks and particular modes of transport. A minimum level of transport infrastructure is necessary for regional competitiveness, but this is not necessarily the same level in all regions (Cambridge Econometrics / Ecorys-NEI report, 2005, p. 24).*

On the other hand, Boschma (2004, p. 1001) compares the competitiveness of regions with that of firms, but states that "there are serious limits in enhancing the competitiveness of regions" compared to firms, because "it is difficult to copy or imitate a successful model from elsewhere, and new trajectories often emerge spontaneously and unexpectedly in space" (Boschma, 2004, p. 1002). Also, the airport infrastructures exert a specific influence on their regions, but within the limits given by the evolutions and morphologies of the metropolitan areas (Cidell, 2015, p. 1125).

Local research in recent years has developed the concept of sustainable mobility which emphasizes the role of the link between spatial planning and transport quality to minimize urban

transport costs as a precondition for sustainable urban development (Banister, 2008, p. 73). However, depending on the regional level of development and local specificities, there are different situations within the EU (Nowak, 2022, p. 46). Thus, Dyr and Ziółkowska (2014, p. 18) show that in Poland there is a weaker link between transport infrastructure and regional competitiveness compared to the impact of energy and water supply infrastructure on regional competitiveness. In the United Kingdom (UK), on the other hand, the good development of transport networks has been manifested in terms of competitiveness through an increase in foreign trade and wages, but at the same time has led to an increase in land prices. (Eddington, 2006, p. 19). In terms of local transport, however, in the UK there has been a lag behind the quality of urban transport networks compared to the situation in European and North American cities, which generates negative effects on regional competitiveness (Docherty *et al.*, 2009, p. 321).

Against the background of interregional changes in competitiveness, Camagni (2002, p. 2395) defines the concept of territorial competitiveness as a phenomenon by which regions, unlike states, are in a single monetary area which makes them compete with each other based on the principle of absolute advantage and not on the principle of comparative advantage. Therefore, the author argues that on a regional scale the success of territorial competitiveness depends to a decisive extent on the quality of each modal transport infrastructure, which clearly surpasses the quality indices of governance (Shala and Qehaja, 2021) and legislative regulations (Rodrigue and Notteboom, 2020, p. 102).

2. Research methodology and data

To investigate the relationship between economic competitiveness and its determinants, we use an econometric model that quantifies the impact of the five quality indicators of the modal transport infrastructures that are successively added to the set of five relevant factors for supporting competitiveness. Basically, we use a transversal gravitational model (by state, at the level of 2019) consisting of a set of multiple regressions that explain the economic competitiveness in the EU (as dependent variable) depending on the basic factors of competitiveness and quality indices of the five modal transport networks (as independent variables) (Table 1, Table 2 and Table 3).

Table 1. The determining parameters of economic competitiveness

DEPENDENT VARIABLE
Economic Competitiveness: Competitiveness Index (World Economic Forum)
INDEPENDENT VARIABLES
BASIC DETERMINING FACTORS:
Labour productivity (The World Bank)

Total investments – Gross fixed capital formation (The World Bank)
Research & Development expenditures (Eurostat)
The act of governance quality: Government Effectiveness Index (The World Bank)
The business environment quality: Economic Freedom Index (The Heritage Foundation)
QUALITY INDICES OF TRANSPORTATION INFRASTRUCTURES:
Road infrastructure quality index (The World Bank)
Railroad infrastructure quality index (The World Bank)
Port infrastructure quality index (The World Bank)
Air transport infrastructure quality index (The World Bank)
Inland waterways quality index (Author's computations)

Source: Author's representation

Table 2. Basic determining factors of economic competitiveness in the EU

Countries	**Labour productivity** *(GDP/ Person employed/ Year)*	**Investment – Gross fixed** *(billion $)*	**R&D expenditures** *(% of GDP)*	**Government Effectiveness Index** *(points)*	**Economic Freedom Index** *(points)*
Belgium	127,390	129.33	3.16	1.14	67
Bulgaria	50,327	12.82	0.83	0.20	69
Czechia	84,220	68.36	1.93	0.95	74
Denmark	113,216	74.04	2.89	1.90	77
Germany	102,132	830.89	3.17	1.52	74
Estonia	76,696	7.90	1.63	1.17	77
Ireland	186,080	213.90	1.23	1.29	81
Greece	69,379	21.70	1.28	0.34	58
Spain	96,505	279.74	1.25	1.00	66
France	115,812	640.67	2.19	1.37	64
Croatia	71,958	13.39	1.08	0.49	61
Italy	103,928	361.82	1.46	0.48	62
Cyprus	62,694	4.85	0.71	0.99	68
Latvia	67,945	7.95	0.64	1.10	70
Lithuania	77,631	11.73	0.99	1.04	74
Luxembourg	156,142	12.33	1.18	1.73	76
Hungary	69,650	44.29	1.48	0.49	65
Malta	86,550	3.22	0.59	0.85	69
Netherlands	106,351	193.45	2.18	1.80	77
Austria	113,616	111.07	3.13	1.52	72
Poland	78,090	109.27	1.32	0.54	68
Portugal	75,124	43.45	1.40	1.16	65
Romania	66,786	56.49	0.48	-0.19	69
Slovenia	81,434	10.63	2.05	1.08	66

Countries	Labour productivity *(GDP/ Person employed/ Year)*	Investment – Gross fixed *(billion $)*	R&D expenditures *(% of GDP)*	Government Effectiveness Index *(points)*	Economic Freedom Index *(points)*
Slovakia	71,598	22.72	0.83	0.58	65
Finland	103,901	63.95	2.80	2.00	75
Sweden	110,728	130.32	3.39	1.70	75
UK	99,947	510.07	1.71	1.48	79
EU-28	**97,693**	**3,480.05**	**1.67**	**1.06**	**47.14**
EU-27	**94,926**	**2,969.98**	**1.67**	**1.04**	**45.96**

Sources: The World Bank, Eurostat, The Heritage Foundation, 2019

Table 3. Economic competitiveness and quality indices of transport infrastructure in the EU

Countries	Competitiveness Index *(points)*	Quality of Roads *(points)*	Quality of Railroad *(points)*	Quality of Port Infrastructure *(points)*	Quality of Air Transport *(points)*	Quality of Inland Waterways *(points)*
Belgium	76.4	4.4	4.1	5.6	5.6	6.1
Bulgaria	64.9	3.4	3.1	4.3	4.5	3.4
Czechia	70.9	3.9	4.5	3.2	5.0	3.8
Denmark	81.2	5.6	4.5	5.8	5.8	3.5
Germany	81.8	5.3	4.9	5.2	5.5	6.3
Estonia	70.9	4.7	3.1	5.6	4.6	3.0
Ireland	75.1	4.4	4.0	5.0	5.5	3.9
Greece	62.6	4.6	3.0	4.8	5.4	2.1
Spain	75.3	5.7	5.4	5.4	5.6	4.7
France	78.8	5.4	5.0	5.2	5.5	5.8
Croatia	61.9	5.6	2.4	4.7	4.8	3.2
Italy	71.5	4.4	4.1	4.7	4.9	4.1
Cyprus	66.4	5.1	-	4.3	5.1	-
Latvia	67.0	3.6	4.6	4.9	5.7	2.7
Lithuania	68.4	4.8	4.6	4.8	4.9	3.1
Luxembourg	77.0	5.5	5.0	4.4	5.6	3.9
Hungary	65.1	4.0	3.8	3.2	4.6	4.1
Malta	68.5	3.3	-	5.1	5.5	-
Netherlands	82.4	6.4	5.7	6.4	6.4	6.3
Austria	76.6	6.0	5.3	3.7	5.2	4.2
Poland	68.9	4.3	3.9	4.5	4.8	4.9
Portugal	70.4	6.0	4.2	4.9	5.0	3.2

Countries	Competitiveness Index *(points)*	Quality of Roads *(points)*	Quality of Railroad *(points)*	Quality of Port Infrastructure *(points)*	Quality of Air Transport *(points)*	Quality of Inland Waterways *(points)*
Romania	64.4	3.0	2.8	3.9	4.6	4.6
Slovenia	70.2	4.9	3.1	4.7	4.6	2.9
Slovakia	66.8	4.0	4.0	3.1	3.8	4.3
Finland	80.2	5.3	5.5	6.4	6.3	4.3
Sweden	81.2	5.3	4.0	5.3	5.7	4.5
UK	81.2	4.9	4.3	5.2	5.3	5.2
EU-28	**72.4**	**4.8**	**4.2**	**4.8**	**5.2**	**4.15**
EU-27	**72.0**	**4.8**	**4.2**	**4.8**	**5.2**	**4.11**

Sources: World Economic Forum, The World Bank, Author's computations, 2019

In the absence of a quality indicator for inland waterways in the established databases, we have built a quality index of this infrastructure based on the value scale compatibility of the quality indices used for the other modes of transport (with values from 1 to 7), according to the following algorithm:

- we started from the eight size classes of the inland waterways (according to ECMT / UNECE Classification, 1992) and for each class we considered the maximum possible value of 100% correlated with the maximum possible value of the quality index of 7. We divided the scale 0-100% by 7, resulting in value ranges (rounded for practical reasons) of 0-15%, 15.1-30%, 30.1-45%, 45.1-60%, 60.1 -75%, 75.1-90% and 90.1-100%; for each range of values we have given in ascending order a benchmark value from 1 to 7: 1 for the range 0-15%, 2 for 15.1-30%, ... , 7 for 90.1-100%;
- for each state we observed the share held by each navigable category and gave it the value 1, 2, ... , 7 corresponding to the range of values in which it falls; if a state does not have navigable sections falling into one of the eight categories we have assigned the value 0 for that category;
- the arithmetic mean of the string of the 7 values thus determined represents the value of the quality index of the inland waterway network of the State concerned.

The choice of the categories of indicators and statistical data mentioned took into account the following selection criteria: the criterion of necessity and opportunity, the criterion of representativeness, the criterion of compatibility of data series and the criterion of data availability. The proposed research is feasible as it is based on a consistent background of data available in the official statistics mentioned.

At the same time, we use as analysis tools reports from European bodies (European Commission, 2011; Annoni and Dijkstra, 2019) and other institutions with reference to economic competitiveness and the development of transport networks in the EU (Cambridge Econometrics /Ecorys-NEI, 2005; World Economic Forum, 2019; The Heritage Foundation, 2019). The reference administrative-territorial units are the EU Member States, for which we use the data of the indicators from the last year (2019) of the UK's presence in the EU.

The variables used meet the conditions of validity with econometric relevance: the classical indicators used as factors of competitiveness are representative (labor productivity, investment, research & development expenditure, quality of public management and quality of business environment) and economically feasible, i.e. are able to avoid the generation of multicollinearity effects that would affect the solidity of the delivered results.

The standard formula of the regression equation will be a logarithmic equation of the type:

$$\ln C_i = a_0 + a_1 \ln P_i + a_2 \ln I_i + a_3 \ln R\&D_i + a_4 \ln G_i + a_5 \ln E_i + a_6 \ln IQ_i + \varepsilon \quad (1)$$

where: C_i – economic competitiveness in each country i;
P_i – labour productivity (GDP/ Person employed/ Year);
I_i – total volume of investments (Gross fixed - % of GDP);
$R\&D_i$ – research and development expenses (% of GDP);
G_i – Government Effectiveness Index of each EU Member State;
IQ_i – Infrastructure Quality Index of each EU Member State;
$a_0, a_1, a_2, \ldots, a_6$ – multiple regression coefficients;
ε – regression residual.

The proposed econometric model includes the following regression equations: an initial equation in which independent quantities are only the basic factors of economic competitiveness to which are added, in turn, one additional independent variable representing the quality of one of the five modal transport systems. Basically, in addition to the initial equation, we construct five more successive regression equations according to the pattern of the standard equation (1), respectively one for each iterative transport network iterated in the gravitational model. Adjusted coefficients of determination (adjusted R^2) and the coefficients of the terms of the equations explain the contribution of the quality of each modal network to the improvement of economic competitiveness in the EU and

render the hierarchy of the qualitative impacts of modal transport infrastructures on competitiveness. By consecutively adding a modal transport network to the initial regression, we obtain the cumulative explanatory proportion that the basic factors of competitiveness have plus the added transport infrastructure; the difference between the adjusted R^2 coefficients of the two successive regressions represents the explanatory contribution of the respective network to the configuration of the economic competitiveness. The evaluation scheme is running for both the EU-28 (with the UK) and the EU-27 (without the UK), in order to determine the extent to which the UK's departure from the Union has changed the weight of the contributions of different modes of transport to EU competitiveness.

By running this evaluation model, we expect the contribution of the package of basic factors to be an overwhelming one in the configuration of competitiveness given their character as components of the competitiveness index, but we want to find out the concrete additional contribution of each modal transport infrastructure to improving competitiveness; at the same time, we want to identify (through the regression terms coefficients) the change in behaviour of each factor in the core package depending on the association with the different transport networks taken into account.

The estimation of the contribution of the transport networks in explaining the economic competitiveness with the help of the econometric model used is valid because it is based on data regarding the whole community space, and testing the veracity of the results obtained is ensured by values below 0.05 of the significance factor (F-significance) for each of the operated regression equations.

In the next stage, we selected the states with the lowest quality values (below the first value quartile) of the transport networks with the highest impact on competitiveness in order to identify priority areas for intervention to rehabilitate the quality of infrastructure with maximum potential for improving the competitive potential. In this context, we will call infrastructures with sustainable quality those transport networks whose quality indices have values located above the limit of the first value quartile, respectively with unsustainable quality the networks with values of quality indexes below the first quartile.

3. Findings and discussions

The results obtained by using the econometric model above confirm the hypothesis that the quality of transport networks has a clearly differentiated contribution of modes of transport on economic competitiveness, and Brexit has moderately changed the share of the contribution of different modes of transport to competitiveness in the EU-27. The adjusted coefficients of determination (R^2 adjusted) and the coefficients of the terms of the equations (Table 4) prove the

iterated assumption and quantify the contribution of each modal transport network to the configuration of economic competitiveness, according to the targeted objective of our research.

Also, the testing of the contribution of the analysed indicators confirms the theoretical assumptions initially assumed. Indeed, the variation in EU-wide economic competitiveness is explained by 88% (in the case of the EU-28) and 87.4% (in the case of the EU-27) by the variation of the basic determinants (labour productivity, investment, research & development expenditures, quality of public management and quality of business environment). This evolutionary model is in fact in line with the dynamics of the average value of economic competitiveness in the EU: for the EU-28 we have the average value of competitiveness of 72.4 points, and for the EU-27 it is 72.0.

Table 4. The relevance of transport infrastructure for economic competitiveness in the European Union

Independent Variables	Multiple Regression Coefficients (*Ordinary Least Squares Method*)											
	(Initial)		(1)		(2)		(3)		(4)		(5)	
	EU-28	EU-27	EU-28	EU-27	EU-28	EU-27	EU-28	EU-27	EU-28	EU-27	EU-28	EU-27
GDP/ Person employed/ Year	0.05**	0.05**	0.04**	0.14**	0.04**	0.05**	0.04**	0.04**	0.03**	0.03**	0.05**	0.05***
Investment	0.01***	0.01***	0.01***	0.28***	0.02***	0.02***	0.01***	0.01***	0.01***	0.01***	0.02***	0.02***
R&D Expenditures	0.05***	0.06***	0.05***	1.95***	0.06***	0.06***	0.05***	0.05***	0.05***	0.05***	0.06***	0.06***
Government Effectiveness Index	0.04***	0.04***	0.03**	4.98***	0.02**	0.04***	0.04***	0.04***	0.04***	0.04***	0.04***	0.04***
Economic Freedom Index	0.30***	0.27***	0.32***	0.18**	0.30***	0.28***	0.26***	0.23***	0.27***	0.23**	0.31***	0.29***
Quality of Road Infrastructure			0.04**	0.06**								
Quality of Railroad Infrastructure					0.06**	-0.01**						
Quality of Port Infrastructure							0.10***	0.10***				
Quality of Air Infrastructure									0.10**	0.16**		
Quality of Inland Waterways											-0.01**	-0.01**
Obs.	28	27	28	27	28	27	28	27	28	27	28	27
Adjusted R^2	0.880	0.874	0.881	0.901	0.913	0.888	0.922	0.918	0.905	0.904	0.899	0.893

Note: ***, **, * represent the level of significance / relevance of 1%, 5%, and 10%, respectively.
Source: Author's proceedings based on World Economic Forum, The World Bank, Eurostat, The Heritage Foundation (2019)

In the EU-28, the hierarchy of modal transport networks in terms of contributing to improving economic competitiveness had the following configuration (Table 5): the quality of port and rail infrastructure had the most significant contribution to improving competitiveness (4.2% and 3.3%, respectively), followed by air infrastructure (2.5%), the network of inland waterways (rivers, lakes and waterways) contributing 1.9%, while road infrastructure had the most modest impact of only 0.1% on the configuration of competitiveness. For the EU-27, the grid of the impact hierarchy keeps on the first position the port infrastructures with a weight of 4.4%, followed on the second position by the air infrastructures with 3%, then by the road infrastructure with 2.7%, the inland waterway

network with 1.9% and railway networks with only 1.4%. The predominance of port infrastructures in explaining the economic competitiveness corroborated with the beneficial effects of the agglomeration savings generated by the ports in the adjacent areas (van Klink and van den Berg, 1998; Sanchez *et al.*, 2003, p. 205; Nordas and Piermartini, 2004, p. 18), positions port intermodal nodes as the most important transport infrastructure for EU economic development.

Table 5. The contribution of the quality of the transport networks to the configuration of the economic competitiveness in the European Union

Competitiveness factors	EU-28 *(%)*	EU-27 *(%)*
Basic factors of competitiveness	88.0	87.4
Quality of road network	0.1	2.7
Quality of railroad infrastructure	3.3	1.4
Quality of port infrastructure	4.2	4.4
Quality of air transport infrastructure	2.5	3.0
Quality of inland waterways network	1.9	1.9

Source: Author's computations based on World Economic Forum and The World Bank data

According to the table above, the departure of the United Kingdom seems to have resulted in an apparent increase in the contribution of the road, port and air network to competitiveness, but this is not because the relative increases in the contribution of the mentioned transport networks result from the addition of factors. basic initials, which in turn declined. Therefore, the departure of the community club by the United Kingdom in 2020 had the effect of reducing by 0.6% the explanatory contribution of the basic factors of competitiveness in the EU-27, and the size of the contribution of modal transport networks, road infrastructure was the only one that brought an increase (2%) in the explanatory contribution to competitiveness, while all other European transport infrastructures reduced their contribution after leaving the UK: the railway network decreased its competitive impact by 2.5%, the inland waterway network by 0.6%, the port infrastructure by 0.4% and the air transport infrastructure by 0.1%. Basically, we can say that Brexit has led to a moderate decline in the competitiveness of the EU-27, and road infrastructure has been the only transport segment that has generated a positive value for the EU-27 by leaving the UK due to its "deadlock road" type of the British road network[†] in the northern and south-western outlying regions, from which the European general road network "escaped" by leaving the UK.

[†] In measuring the quality of road networks, the World Economic Forum allocated a score of 4.9 points for the quality of the UK road network, a size very close to the EU-28 average of 4.8 points. This is largely due to the "deadlock" road

By summing up the contributions of all modal transport infrastructure, we found that within the EU-28 all transport networks explained the improvement in economic competitiveness by 12%, and with Brexit the loss of British transport networks led to a decrease in EU-27 competitiveness with -1.6%.

In terms of the impact of an elementary infrastructure unit (1 km of motorway, 1 km of railways, 1 point of the index of efficiency of government or economic freedom, etc.) on economic competitiveness, the situations in the EU-28 and EU-27 they are much closer or even identical. If we work on a scale of relevance of 5%, we see from Table 2 that the most striking decreases refer to the reduction per unit of the quality of the business environment (economic freedom) with the departure of Great Britain, which reflects the high degree of economic favorability offered by the Anglo-Saxon regulatory framework compared to the European one. From this point of view, the departure of the UK is a loss for the EU-27. On the other hand, in the segment of good governance, the discrepancy is in favour of the EU-27 after the departure of Great Britain and is visibly expressed mainly by the coefficient of determination of the regression equation regarding the road network; on the other regression equations the respective divergence is more attenuated. The explanation stems from the reluctance that the United Kingdom has always had towards European decisions, which is reflected in the gap between the values of the coefficients in question (4.98 for EU-27 compared to 0.03 for EU-28).

The interpretation of the regression coefficients shows that, on the road infrastructure, to increase by 1% the level of competitiveness it was necessary to increase the road quality by 0.04 points in the EU-28 and by 0.06 points in the EU-27, despite the increase of the road contribution by 2% shaping competitiveness after Brexit. The railway infrastructure highlights a bizarre situation resulting from the technical inhomogeneities of the mainland railway networks (differences in gauge, type of power supply, etc.), elements that still keep the European railway insufficiently competitive: in the EU-28 the 1% increase in competitiveness is explained by the 0.06 point increase in the quality of railway infrastructure, while in the EU-27 the 1% increase in competitiveness is accompanied by a 0.01 point decrease in railway quality! This is reflected in the sharp decline in competitive rail input from 3.3% to just 1.4% after Brexit, which shows that the rail contribution to competitiveness in the EU-28 was artificially iterated by the very good contribution of the British railway which thus blurred the insufficient railway contribution. from the mainland. On the other hand, port infrastructure, which has the largest explanatory contribution to both economic competitiveness in both the EU-28 and the EU-27 as a whole, also shows the same consistent contribution at unit level: with or without the UK

situation in the far north of Scotland and the Cornwall Peninsula, which has led to a certain reduction in the quality index of the UK road network, despite very high standards of reliability on the British road network.

a 1% increase in competitiveness is ensured by a 0.1 point increase in the quality of port infrastructure, in line with the contribution of over 4% to the configuration of competitiveness with or without the UK. In the field of air transport in the EU-28, each percentage increase in competitiveness was explained by a 0.1 point increase in the quality of air infrastructure, and in the EU-27 an increase of 0.16 points is needed, which attests to the net superior quality of British airports. For inland waterway infrastructures, unfortunately, their quality not only does not contribute to increasing competitiveness, but also seems to work in the opposite direction: with an increase in economic competitiveness on the continent by 1% the quality of inland waterways decreases by 0.01 points! This shows, as in the case of the railways, poor maintenance and underutilization in relation to the opportunities offered by these infrastructures.

Also, the comparative unitary contribution of each mode of transport illustrates the behavioral hierarchy of modal transport networks before and after Brexit. Thus, in the EU-28 the 1% increase in competitiveness was ensured by the increase by 0.04 points of the quality of the road infrastructure, by 0.06 points of the quality of the railway infrastructure and by 0.1 points of the port and air infrastructure. In the EU-27, for the same 1% increase in competitiveness, it is necessary to increase the quality of the road network by 0.06 points, by 0.1 points of the port infrastructure, by 0.16 points of the air infrastructure, while decreasing by 0.01 the quality of the railway network.

Instead, the basic factors of competitiveness have evolved relatively constantly. In order to increase economic competitiveness by both the EU-28 and the EU-27, a 5% increase in labour productivity, a 1 billion euro increase in total investment volume and a 5% increase in expenditure on R&D in the EU-28 and by 6% in the EU-27, by 0.04 points in the quality of the governing act and by 0.30 points in the EU-28, and by 0.27 points in the EU-27 by the quality of the business environment. The analysis of the unitary impact of the factors of competitiveness clearly shows that the quality of the business environment, i.e. legislation and economic freedoms, is the most important element for increasing competitiveness in the EU.

In order to rank the priorities of intervention, we identified the states with the lowest quality of modal networks with the greatest impact on economic competitiveness. As we have seen, port infrastructures represent the transport systems with the highest potential for increasing competitiveness, therefore the states with the poorest quality of these infrastructures (with values below the first value quartile) constitute the first priority for intervention: Bulgaria, Czech Republic, Cyprus, Hungary, Austria, Romania and Slovakia. For these states, the recovery of port capacities and their interconnection in the form of intermodal hubs is the measure that would most quickly lead to the improvement of economic competitiveness.

The second modal category with a relevant impact on competitiveness in the EU-27 is the category of air transport infrastructures. Among the states with the lowest quality of air infrastructures (below the first value quartile) are Bulgaria, Estonia, Hungary, Romania, Slovenia and Slovakia. For these states, improving air infrastructures (including their intermodal connection) would be the second feasible priority that would bring more competitiveness. If we consider the EU-28, the second priority would be to improve the railway infrastructure, a recommendation valid for Bulgaria, Estonia, Greece, Croatia, Romania and Slovenia. We note that in any variant (EU-28 or EU-27), Bulgaria Estonia, Romania and Slovenia are eligible for the rehabilitation of both their infrastructures (air and rail) bearing premises for improving economic competitiveness. At the same time, it is noted that in the post-Brexit era a number of countries such as Bulgaria, Hungary, Romania and Slovakia are on the list of both priority needs for improving competitiveness (rehabilitation of both their port and air infrastructure).

Conclusions

The results of our analysis show that in both the EU-28 and the EU-27, the quality of transport networks has a differentiated impact on modes of transport on economic competitiveness, and Brexit has moderately changed the share of the contribution of different modes of transport on EU-27 competitiveness. The UK's exit from the EU in 2020 decreased by 0.6% the contribution of the basic factors of competitiveness, at the same time with the decrease of the contribution of the transport networks. Brexit has led to a slight slowdown in European competitiveness across the EU-27, and road transport has been the only component of transport systems to increase its competitive contribution to the EU-27, given the peripheral nature of the British road network.

Within the EU-28 all transport networks made a 12% contribution to improving economic competitiveness, but with Brexit the loss of British transport networks led to a decrease in competitiveness for the EU-27 as a whole by 1.6%. In the EU-27, the hierarchy of the competitive contribution of modal transport networks places port and air infrastructures at the top of the ranking, followed by road, inland waterways and railway infrastructures.

Across the EU as a whole, there is a low impact on the competitiveness, especially in the post-Brexit era, of rail networks and inland waterways, i.e. exactly the transport systems on which there are high expectations given the trend of sustainable development and green EU approaches, which shows poor maintenance and underutilization of these infrastructures in relation to the opportunities they offer.

Among the basic factors of competitiveness, the quality of the business environment registered the most relevant decline after Brexit. Economic freedom and the quality of legislation have had the most visible impact on the decline in competitiveness in the EU-27, reflecting the high degree of economic favourability offered by the Anglo-Saxon regulatory framework compared to the European one. On the other hand, in the segment of good governance, the discrepancy is in favor of the EU-27 after the departure of Great Britain amid the reluctance that the United Kingdom had permanently towards European decisions.

The reporting of the spaces with the lowest quality of the most contributing transport networks to the creation of competitiveness illustrates the intervention priorities for increasing competitiveness and demonstrates the need to profile spatially differentiated policies for the development of different transport networks. Differentiated approaches would also be useful along the lines of budget allocations for different programs for different states. Thus, for Bulgaria, the Czech Republic, Cyprus, Hungary, Austria, Romania and Slovakia, the draining of the community's financial effort should aim at the rehabilitation of port capacities, which, for these spaces, would most quickly lead to the improvement of the competitive potential. Also, a customized approach is required for Bulgaria, Estonia, Hungary, Romania, Slovenia and Slovakia, aimed at connecting budgetary policies with those aimed at improving the quality of air infrastructures, an approach that would bring more competitiveness for the mentioned states. At the same time, double priority programs are desirable for Bulgaria, Hungary, Romania and Slovakia, aimed at improving both port and air infrastructures, as conditions for improving economic competitiveness.

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