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## DETERMINANTS OF LOGISTICS' PERFORMANCE: A NEW APPROACH TOWARDS ANALYSIS OF ECONOMIC CORRIDORS AND INSTITUTIONAL QUALITY IMPACT

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**Abstract.** Recently, the relationship between economic corridors and logistics performance has been intensively investigated. However, only few studies analyze other factors through which the economic corridors affect logistics quality. Therefore, we aim to estimate the impact of economic corridors on logistics performance, in a way to account for institutional effect, by constructing multiplicative interaction model. Our proposed model was tested using the difference-in-differences estimator and panel data of 36 European countries along The Belt and Road Economic Corridors between 2007 and 2018. Considering robustness tests and appropriate estimation techniques our analysis showed that economic corridors affect countries logistics performance via institutional quality. However, several limitations need to be acknowledged. The first one is related to the availability of the data as The Belt and Road Initiative (BRI) was introduced only recently, limiting the length of the analyzed period. Secondly, no official or generally accepted definition of the BRI exists, thus it is very difficult to identify its geographical scope. Therefore, applying the same methodology for data, several years after the announcement of BRI, future research could include more countries and additional time periods to explore the matter in more detail. Despite the fact, our approach assumes that the initiatives of economic corridors should be accompanied by stronger institutions and good governance to have higher levels of countries logistics performance. Moreover, this study confirms that economic corridors is very complex economic phenomenon and further studies should consider the role of moderators of this nexus.

**Keywords:** economic corridors; logistics performance; belt and road initiative; institutional quality; moderators; interaction term

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### 1. Introduction

In the context of globalization, the impact of economic corridors on international trade, investment, economic growth and logistics of countries and regions along them, acquires special importance. The development of economic corridors is closely related to the changes in countries logistics performance. (An et al., 2021; Li et al., 2021; Martí et al., 2014; Wang et al., 2018) Thus, the relationship between economic corridors and logistics performance raises a reasonable interest in the scientific community. Firstly, regional co operation on infrastructure improvements based on economic corridors could strengthen connectivity and reduce trade cost while at the same time make trade easier and foster economic growth of corridor economies. It is known that removing barriers, caused by national borders, and opening new transport markets, will lead to cross-border

cooperation, that significantly reduce geographical inequalities between countries. Secondly, the construction of new railways and roads creates added value for owner country, but if the new connection is international, the value acquires not only to the owner country, but also to the neighboring countries that use this connection. Consequently, further investigation of this issue could provide new insights that the investment in infrastructure will not only bring benefits but can also invoke spillover effect on individual countries' trade and gross domestic product. In other words, the country that invest in the development of transport infrastructure will not necessarily benefits of it the most. Thirdly, many studies, refer to customs indicator as one of the most important factors influencing the efficiency of the country's logistics performance (e.g. Kulish et al., 2021). In developing countries, customs indicator is very sensitive to the quality of public services and the degree of its independence from political pressure. The literature broadly agrees that the low level of corruption and (or) the high level of political stability leads to better logistics performance in a country (Arvis et al., 2014; Seabra et al., 2016; Wong & Tang, 2018a). Accordingly, the studies on the impact of economic corridors in the aspect of institutional quality is of particular importance.

The introduction of “One belt, one road” initiative has led to a new wave of studies investigating the relationship of economic corridors and logistics performance. However, only few studies analyze other factors through which the economic corridors affect logistics quality. Therefore, we aim to estimate the impact of economic corridors on logistics performance, in a way to account for institutional effect by constructing multiplicative interaction model. The analysis and evaluation of countries logistics performance in the context of economic corridors has become a difficult task. First, the phenomenon of economic corridors is not unambiguously defined. Second, considering the complexity of logistics services, the scientific literature differently treats the concept of logistics performance and its main indicators. Hence, in this article we construct a novel interpretation of economic corridor phenomenon together with a concept of logistics performance by providing the refreshed multiplicative approach to study the effect of institutional quality, through which economic corridors is affecting countries logistics performance.

## **2. The theoretical research direction of economic corridors**

### **2.1. The interpretation of economic corridor phenomenon**

In scientific literature the phenomenon of economic corridors is analyzed in various aspects. The origins of economic corridors are partly explained by the theory of new economic geography (Fujita & Krugman, 2003; P Krugman, 1998; Krugman, 2009, 2011), however in the current literature (Arvis et al., 2014; Arvis et al., 2018; De & Iyengar, 2014) the concept of economic corridors has not yet been fully disclosed.

In order to define the complex nature of the corridor phenomenon, researches present various classification systems in which economic corridors are considered as analytical (Chapman et al., 2003; de Vries & Priemus, 2003; Priemus & Zonneveld, 2003; Witte et al., 2016) or political concept (Gleave, 2018; Putten, 2016). Accordingly, a corridor could be understood in four different dimensions (de Vries & Priemus, 2003; Priemus & Zonneveld, 2003; van Duinen, 2013): (1) as a transport infrastructure axis; (2) as an economic development axis; (3) as an urbanization axis; (4) as an institutional axis. Witte & Spit (2015) summarizing the ideas of Chapman et al. (2003); de Vries & Priemus (2003); van Duinen (2013) proposed the concept of corridors, according to which the phenomenon of corridors is understood as a complex interaction between transport capacity, economic benefits, institutions and spatial structures. There is a broad consensus in the academic community that the development of transport corridors eventually results in economic corridors (De & Iyengar, 2014) and every successful trade route is an economic corridor.

While it is important to understand the main differences between transport, trade and economic corridors, their general similarity is to seek spatial economic growth. In addition, there is an evolutionary relationship between trade and the economic corridor, which means that the first is a natural extension of the latter.

## **2.2. Economic corridors of The Belt and Road initiative**

The Belt and Road initiative (BRI) is an abstract and ambiguous concept. The academic community discusses the essence (Barisitz, 2020; Putten, 2016), and structure of the BRI, (Bardal', 2018), disagrees on terminology as no official or generally accepted definition of the BRI exists (Hillman, 2018; Wang et al., 2018). Some authors emphasize the difficulties in assessing the economic benefits of the initiative (Besharati et al., 2017; Hillman, 2018; Ruta et al., 2019; Blanchard, 2018; Barisitz, 2020; Lai et al., 2020; Buckley, 2020; Mardell, 2020; Lugt & Wang, 2020).

Many papers analyze the separate routes of Belt and Road economic corridors (Wong, 2018; Barisitz, 2020; Raza et al., 2014; Gudjonsson & Nielsson, 2015; Staalesen, 2013; Tillman et al., 2018; van Leijen, 2018; Taksami, 2018; Barisitz et al., 2018; Brînză, 2019; Levitin et al., 2016; Zhylankozova, 2018), and the benefits of investment in transport infrastructure for the countries along them (Brînză, 2019; Zeneli, 2020; Scimia, 2019; Champion, 2019; Jeffrey, 2019).

According to Chinas Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road, BRI is the synthesis of two main components – “Silk Road, economic belt,, or “One belt” and XXI century maritime silk road or “One road”. However, Chinas Arctic Policy announced in 2018, introduces an additional component of the BRI the "Polar Silk Road". The lack of a generally accepted definition of the BRI allows for the evolution of the concept of the initiative.

In summary, the concept of corridors, in a broad sense, highlights the fact, that the corridors are an infrastructure system that connects transport, economic, political, demographic, and other interrelated processes in a linear manner. The main characteristic feature, reflected in all dimensions of the research of economic corridor is their connectivity.

## **2.3. The concept and main indicators of logistics performance**

Logistics is a key component of modern production and distribution systems, significantly affecting the economic development of countries. (Halaszovich & Kinra, 2018; Mariano et al., 2017; Rezaei et al., 2018; Savy, 2016) The nature of logistics is determined by the resources of infrastructure, technology and the labor force of required competencies, which are directly dependent on institutional aspects (Arvis et al., 2018; Martí et al., 2014; Savy, 2016). In the literature, the theoretical basis of the logistics performance is related to the theories of institutional economics (Wong & Tang, 2018a,b). Given the multifaceted nature of logistics services, the scientific literature treats the definition of logistics performance and its main indicators differently. It is agreed that one indicator cannot describe the level of logistics performance (Chow et al., 1994; Stainer, 1997; Green et al., 2008). Thus, the aim of researchers and practitioners is to find a set of indicators that covers many, or all, of the most important aspects of logistics services. (Andersson et al., 1989; Chow et al., 1994; Stainer, 1997).

The effectiveness of connectivity of economic corridors is analyzed through the World Bank's Logistics Performance Index (LPI), which is considered by both researchers and practitioners as a unique tool for benchmarking that explains the link between logistics processes and international trade. (Arvis et al., 2018). LPI consists of six different indicators reflecting main drivers of countries logistics performance: (1) the efficiency of customs and border management clearance (“Customs”); (2) the quality of trade and transport infrastructure (“Infrastructure”); (3) the ease of arranging competitively priced shipments (Ease of arranging shipments”); (4) the competence and quality of logistics services—trucking, forwarding, and customs brokerage (“Quality of logistics

services”); (5) the ability to track and trace consignments (“Tracking and tracing”); (6) the frequency with which shipments reach consignees within scheduled or expected delivery times (“Timeliness”)(Arvis et al., 2018).

Logistics services are mostly provided by private companies, but the infrastructure is in many cases managed by public services. Countries with policy goals set specifically for transport infrastructure investment may create favorable conditions for private companies to provide high-quality and lower-cost logistics services.

According to the theories of institutional economics, which partly explain the efficiency of logistics performance, and summarizing the scientific literature analyzing LPI and its indicators it can be stated that a countries logistics performance is a measure of logistics efficiency determined by political stability and the institutional environment, containing of the resources of infrastructure, technology, and the labor force of required competencies.

#### **2.4. The interaction of economic corridors and institutional quality**

The relationship between economic corridors and the logistics performance is widely analyzed by large number of authors. However, these studies are limited as they do not cover other factors through which the economic corridors affect logistics quality.

In the literature, the moderating role of institutional quality seeking to explore the complexity of economic corridors and their impact on logistics performance to the best of our knowledge, has not been analyzed yet. Authors focused on moderating role of corruption (Larson, 2020; Uca et al., 2016), competitiveness, institutions (Haavisto & Vaillancourt, 2017; Halaszovich et al., 2020; Soh et al., 2021; Uyar et al., 2021), trade volumes (Uca et al., 2016), economic growth (Civelek et al., 2015) and other factors affecting logistics performance, but not the impact of economic corridors to logistics performance. However, authors emphasized the importance of institutional quality to be significant for the development of economic corridors (De & Iyengar, 2014) and in the context of BRI, the linkage between regional institutions and participation in Global value chains (GVC) appeared to be significant for encouraging firms to participate in GVCs (Ge et al., 2020); or the importance of conditions of institutional quality for attracting foreign direct investment (Aibai et al., 2019); of the role of institutional quality in the field of environmental protection (Wu et al., 2021).

Ge et al. (2020) revealed that a large gap exists in institutional quality between BRI countries and non-BRI countries. BRI countries have much weaker institutions than non-BRI countries. Countries with better institutions have a higher GVC participation ratio in those industries that are highly dependent on these institutions. Furthermore, weak institutions in BRI countries are significant barriers for GVC development and regional integration.

Aibai et al. (2019) found that foreign direct investment plays a more significant role in promoting financial development in countries with higher quality institutions. This indicates that a good institutional environment in the host country will help enhance the positive role foreign direct investment plays in its financial development. Thus, BRI countries are supposed to take measures to improve their institutional quality and attract foreign direct investment.

De & Iyengar (2014) showed that institutional support of economic activities along transport corridors are essential to increase regional trade and economic welfare. Moreover, good institutional quality is crucial for converting cross-border corridors into economic corridors.

The above-mentioned studies suggest that the quality of institutions can be understood as one of the key factors determining the impact of economic corridors on countries logistics performance. Accordingly, favorable policy decisions in the transport corridors, coordinated action by the responsible authorities and investment in "soft"

infrastructure are gradually leading to the transformation of transport corridors into economic corridors. Thus, a well-functioning public sector ensures the stable operation of governments and the efficient development of transport infrastructure. Consequently, when analyzing the impact of economic corridors on logistics performance, it is necessary to emphasize the link between the high level of countries logistics performance, the institutional quality and increased economic activity in the regions falling within the area of specific economic corridors.

### **3. Methodology: the institutional aspect**

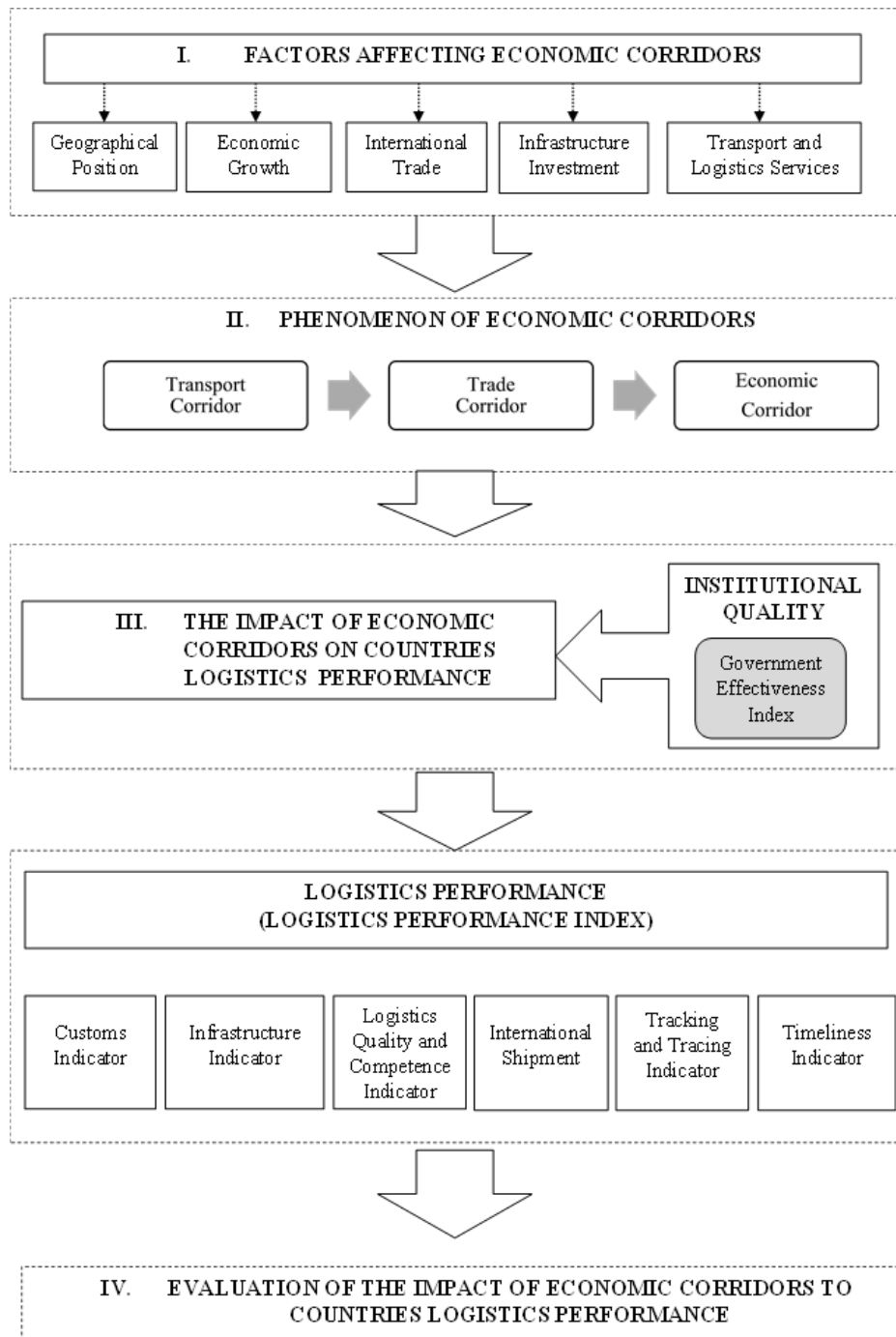
#### **3.1. Conceptual framework for evaluating the impact of economic corridors to logistics performance of European countries**

Studying the effect of economic corridors on the level of logistics requires the adoption of theoretical model that can serve as a foundation for the econometric specification. We estimate the effect of economic corridors on countries logistics performance relying on theories of new economic geography and new structural economics, while bearing in mind the evolutionary context of the corridor phenomenon. The conceptual framework for evaluating the impact of economic corridors to logistics performance of selected European countries consist of four dimensions: (I) the factors affecting economic corridors; (II) the phenomenon of economic corridors; (III) the impact of economic corridors on countries logistics performance, moderated by institutional quality; (IV) the evaluation of the impact of economic corridors to countries logistics performance (Fig. 1).

Empirical studies on the relationship between economic corridors and logistics performance lack of general provisions on which indicators most clearly reflect the phenomenon of economic corridors. However, the analysis of the characteristics of individual economic corridors suggests, that the main factors influencing the development of economic corridors are geographical position of a country, economic growth, international trade, infrastructure investment and logistics services. Current literature agrees that defining and measuring institutions across different territorial context is proven to be difficult (Álvarez et al., 2018; Barbero et al., 2021). In this conceptual framework by institutional quality, we mean government effectiveness that captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures (Busse & Hefeker, 2007) agrees that bureaucratic quality is closely associated with institutional strength of a particular country.

Uyar et al. (2021) highlights that the main determinants of logistics performance are related to public governance. The authors found that government effectiveness, as a proxy for institutional quality, can foster countries logistics performance through improvement in infrastructure as well as by formulating of sound and precise customs clearance process.

It should be noted that, government effectiveness depends on the political culture of public governance that was influenced by various historical circumstances. This is especially relevant in the case of European countries, some of which inherited the institutional environment from the West world and the other from the post-war regimes of the East. Western European countries, avoiding the ideological influence of the socialist regime, have developed a strong institutional and good governance culture. Nevertheless, the unequal distribution of the influence of the Eastern and Western bloc in Europe encourages the analysis of the countries' institutional environment and its significance for individual economic phenomena in our case the impact of economic corridors to countries logistics performance. This type of research where institutional quality is considered a moderator of the impact of economic corridors has remained mostly overlooked in literature.



**Fig. 1.** Conceptual framework for evaluating the impact of economic corridors to European countries logistics performance

### 3.2. Research methods

To evaluate the impact of economic corridors on logistics performance of selected European countries, it is necessary to find a credible way to approximate what would have happened had the BRI economic corridors not taken place. The impact of economic corridors or, in other words, the change that can be credibly attributed to economic corridors is evaluated by comparing what is observed after countries accepted BRI initiative with what would have happened to those countries without the BRI. For this type of evaluation and seeking to understand how the economic corridors has been implemented, simple indicators are not sufficient, it is necessary to evaluate what effect *other* factors may have had on the European countries' logistics performance in the context of BRI. This kind of approach in the literature is defined as the difference-in-differences method (DID), firstly introduced by Ashenfelter & Card (1985) and later in theoretical work of Donald & Lang (2007), Imbens & Wooldridge, (2009) adapted for panel data.

The DID approach for a panel of countries takes the following form:

$$\ln Y_{i,t} = \alpha + \beta \times BRI_{i,t} + c_k C_{k,i,t} + \theta_t + \varepsilon_{i,t} \quad (1)$$

Where  $i = 1, \dots, N$  for each country in the panel and  $t = 1, \dots, T$  refers to the impact period. Variables given are in natural log form. Accordingly,  $\ln Y_{i,t}$  is overall logistics performance index of country  $i$  over the period  $t$  (and alternatively customs and infrastructure indicator);  $\beta$  is the parameter of DID estimator;  $BRI_{i,t}$  is a dummy variable, which equals to 1 if country  $i$  is one of BRI countries and 0 otherwise.  $BRI$  varies over time  $t$ , as the countries  $i$  joins the initiative at different time periods.  $C_{i,t,k}$  is a vector that consist of  $k$  number of factors that may also have impact on the logistics performance of a country  $i$  over the period  $t$ .  $\theta_t$  are time fixed effects.  $\varepsilon_{i,t}$  is the error term which is often called the *idiosyncratic error* or time-varying error because it represents unobserved factors that change over time and affect  $\ln Y_{i,t}$ .

In this study, we apply DID regression to compare the changes of logistics performance of selected European countries after the BRI to that with non-BRI countries. All countries in the sample are divided into two groups, namely treatment group (BRI countries) and control group (non-BRI countries).

There is a consensus in the academic community that the different time periods of involvement of the countries in the BRI initiative makes the division of treatment and control groups a difficult task (Yu et al., 2020). Therefore, as shown in Table 1, in this study, the division of European countries is based on the *de jure* criterion, i.e., undersigned cooperation agreements in the context of BRI.

**Table 1.** The division of treatment and control groups based on the *de jure* criterion

BRI countries (23)	Non-BRI countries (13)
Austria, Belarus, Belgium, Cyprus, Bulgaria, Denmark, Czech Republic, Estonia, Greece, Croatia, Hungary, Malta, Montenegro, Portugal, Lithuania, Latvia, Poland, Romania, Serbia, Slovenia, Slovakia, Turkey, Ukraine.	Germany, Finland, Italy (until 2019), Netherlands, Norway, Sweden, France, Iceland, Luxembourg, Russian Federation, Spain, Switzerland, Czech Republic.

To define the complex nature of the corridor phenomenon, a comprehensive approach to evaluation their impact is needed. A comprehensive approach requires the evaluation of different channels like institutional effect through which economic corridors contributes to logistics performance of a country.

We transform our general model to include interaction between variable of Government effectiveness index to proxy institutional effect. Following equation correspond to and will be used to model institutional effect:

$$\ln Y_{i,t} = \alpha + \beta_1 \times BRI_{i,t} + \beta_2 \times GE_{i,t} + \beta_3 (BRI_{i,t} \times GE_{i,t}) + c_k C_{k,i,t} + \theta_t + \varepsilon_{i,t} \quad (2)$$

Where  $GE_{i,t}$  is a proxy for institutional effect, multiplicative term  $BRI_{i,t} \times GE_{i,t}$  allow us to examine how the institutional effect moderates the effect of BRI economic corridors on logistics performance of selected European countries.

Interaction term  $\beta_3$  tests the conditional hypothesis that the institutional environment of a country shapes the impact of economic corridors on logistics performance. If coefficient of interaction term was statistically significant and negative, ( $\beta_3 < 0$ ) it would give an evidence that institutional environment negatively affects the impact of economic corridors to countries logistics performance. Positive coefficients on interaction term ( $\beta_3 > 0$ ) would indicate that better institutional quality in BRI countries leads to higher levels of logistics performance. However, as noted by (Dawson, 2014) the size and precise nature of this effect is not easy to divine from examination of the coefficients alone.

A large body of literature provides recommendations on how to test conditional hypotheses using multiplicative interaction models. (Brambor et al., 2006) suggests two fundamental rules how multiplicative models should be analysed: (1) all constitutive components of the interaction term (in our case BRI and GE) must be included in the model separately in the equation and cannot be interpreted as unconditional marginal effects; (2) the research should focus on computing substantively meaningful marginal effects and confidence intervals.

Following the rule (2), we rearrange Eq. (2) as suggested by (Dawson, 2014) to get the expression which would show that slope of economic corridors on logistics performance is conditional and manifests through the effect of institutional quality and all possible interactions between them:

$$\ln Y_{i,t} = [\alpha + \beta_2 \times GE_{i,t}] + [\beta_1 + \beta_3 \times GE_{i,t}]BRI_{i,t} + c_k C_{k,i,t} + \theta_t + \varepsilon_{i,t} \quad (3)$$

To evaluate whether the relationship (slope) between economic corridors and logistics performance is significant at a particular level of institutional quality we perform a simple slope test by substituting the value of GE into regression equation and calculating the standard error of the slope. The standard error of the sum ( $\beta_1 + \beta_3 GE$ ) is calculated by:

$$S_{(\beta_1 + \beta_3 GE)} = \sqrt{var(\beta_1) + GE^2 var(\beta_3) + 2GE cov(\beta_1, \beta_3)} \quad (4)$$

Our strategy for choosing research methods is based on theoretical assumptions of (Imbens & Wooldridge, 2009) for estimating unobserved effects panel data using DID method.

We employ in our analysis a pooled Ordinary Least Square (OLS) estimator that is based on the time-demeaned variables and is called the Fixed effects estimator (FE). The FE on equations (1)-(2) uses the time variation in dependent variable and independent variables within each cross-sectional observation. Under a strict exogeneity assumption on the explanatory variables, the fixed effects estimator is unbiased: roughly, the idiosyncratic error  $\varepsilon_{i,t}$  should be uncorrelated with each explanatory variable across all time periods. It should be noted that any explanatory variable that is constant over time for all  $i$  gets swept away by the fixed effects transformation. Therefore, we cannot include variables based on countries historical (colonial or not, common language or not, and etc.) or geographical (common border or not, landlocked or not and etc.) background that other authors often use while investigating the relationship between economic corridors and logistics performance.

As the panel data have a time series and cross-sectional dimensions, we will use robust estimation of the covariance matrix that will correct heteroscedasticity (if variance of the error term differs across cross sectional units) and autocorrelation (if covariance of the errors across the units is non-zero in each time period). In that case, we will use the robust estimator (HAC approach) that is recommended by (Stock & Watson, 2008) for the panel data with relatively large  $n$  and small  $T$  variety. To validate the selected model Pesaran test for cross sectional dependence and Wald test for time-dummies should also be conducted.

### **3.3. Data specification**

The empirical verification of the proposed conceptual framework is grounded on the unbalanced panel of 36 selected European countries, over the period 2007-2018. Defining the research period and dividing it into stages is an important aspect of the methodology for evaluating the impact of economic corridors on logistics performance in European countries.

The 2007-2018 period is divided into two stages at two year intervals, as the World Bank conducts LPI survey every two years.: (I) 2007, 2010 and 2012 – this is the time before the launch of the BRI initiative and the start of investment in infrastructure in the countries along BRI economic corridors, in the context of BRI; (II) year 2014 marks the beginning of the development of BRI economic corridors in European countries; year 2016 marks the Chinese investments in Balkans in the context of BRI; year 2018 marks the announcement and development of The Polar Silk Road.

This approach to the research periods allows to compare the level of logistics performance in European countries before and after the emergence of BRI economic corridors.

Full description of variables, selected to evaluate the impact of economic corridors to European countries logistics performance, accounting for institutional aspect, their sources, descriptive statistics, and short names of variables, used later in the analysis are presented in Table 2.

For numeric form of logistics performance, the overall LPI index was used together with customs and infrastructure indicators. To proxy the institutional effect the transformed (+2,5) Governance effectiveness indicator was used.

Seeking to determine not only the impact of economic corridors on countries logistics performance, but also the relationship of this impact to trade and economics of European countries, additional indicators of international trade, gross domestic product (controlling the size of the country), population density (controlling the size of the country's market), foreign direct investment, investment, labor force and human development index were chosen as control variables. The data used in the analysis was collected from either World Development Indicators (WDI) database or from Worldwide Governance Indicators (WGI) database, except for Investment that was taken from Penn World Table version 10.0 database, Foreign direct investment that was taken from UNCTAD database and Human development index that was taken from UNDP Human Development report. All data are converted into natural logarithm for measurement uniformity.

The traditional approach to evaluate international trade is to use the sum of import and export. However, according to OECD reports, in today's global economy, this type of trade only represents around 30% of all trade in goods and services and about 70% of international trade today involves GVCs (OECD, 2018, 2020). For this reason, we will use the ratio between export and import. The main idea of this approach is that countries located at the beginning of the economic corridor (upstream) tend to import fewer intermediates and export more, this way the ratio will be lower than 1. In contrast, countries that specialize in assembly and are located at the other

end of the economic corridor (downstream) tend to import more intermediate goods and export relatively less, so the ratio will be close or equal to 1.

The Human Development Index (HDI) is a summary composite measure of a country's average achievements in three basic aspects of human development: health, knowledge, and standard of living. Considering, that logistics is organized by freight forwarders, and their work is essentially intellectual, requiring the competencies necessary to ensure the smooth flow of international trade, HDI is selected to control for education level of a country. Knowledge, as measured by mean years of schooling and expected years of schooling secure the goods, is the strongest component of HDI.

**Table 2.** Full description of variables, their sources, descriptive statistics, and short names of variables, used in the analysis

Abbreviation	Full Name	Explanation and measurement unit	Mean	Median	Std. dev.	Min.	Max.
<b>Logistics performance</b>							
LPIO	Overall Logistics performance index	Logistics Performance Index overall score reflects perceptions of a country's logistics based on efficiency of six sub indicators The index ranges from 1 to 5, with a higher score representing better performance.	3,35	3,35	0,503	2,28	4,23
LPIC	Logistics performance index Customs indicator	Logistics professionals' perception of the efficiency of country's customs clearance processes (i.e. speed, simplicity and predictability of formalities), on a rating ranging from 1 (very low) to 5 (very high).	3,15	3,17	0,564	1,94	4,21
LPII	Logistics performance index Infrastructure indicator	Logistics professionals' perception of country's quality of trade and transport related infrastructure (e.g. ports, railroads, roads, information technology), on a rating ranging from 1 (very low) to 5 (very high).	3,28	3,19	0,626	2,07	4,44
<b>Economic Corridors</b>							
BRI	Countries along „One belt, One Road „economic corridors	Dummy variable, which equals to 1 if country i is one of BRI countries and 0 otherwise	0,241	0,000	0,429	0,000	1,00
<b>The Quality of Institutions</b>							
GE	Government Effectiveness Index	Government Effectiveness captures perceptions of the quality of public services and the degree of its independence from political pressures. Estimate ranging from approximately -2.5 to 2.5.	3,41	3,48	0,767	1,39	4,85
<b>Control Variables</b>							
TR	Trade	The ratio of import and export of a country	1,02	1,02	0,216	0,502	1,71
GDP	Gross Domestic Product	GDP in constant 2015 prices, expressed in U.S. dollars	4,28e+011	4,28e+011	4,28e+011	4,28e+011	4,28e+011
PD	Population Density	People per sq. km of land area	147,	93,6	229,	3,11	1,51e+003

F	Foreign Direct Investment	Foreign direct investment inward stock percentage to GDP	138,	47,8	334,	2,64	1,86e+003
I	Investment	Investment at current national prices	8,86e+005	1,19e+005	2,99e+006	655,	2,29e+007
L	Labor force	Total Labor force comprises people ages 15 and older who supply labor for the production of goods and services during a specified period.	9,80e+006	4,36e+006	1,50e+007	1,67e+005	7,59e+007
HDI	Human Development Index	A composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge, and a decent standard of living.	0,863	0,868	0,0552	0,712	0,956

**4. Evaluation of the Impact of Economic corridors on European countries Logistics performance**

**4.1. Empirical results**

As explained above, the FE estimator was used to estimate Equation (2). The analysis covers three dimensions of logistics performance (Table 3). We used every indicator of LPI individually as each of them measures a different facet of the logistics performance of a country. However, only three of them, i.e. Overall logistics performance index (LPIO), Logistics performance index infrastructure indicator (LPII), Logistics performance index customs (LPIC) appeared to show significant results. Results for each separate regression shows that the relationship between economic corridors and logistics performance is statistically significant and negative.

The negative coefficients indicates that economic corridors reduce level of logistics in selected European countries. This could be interpreted as following. The literature on economic corridors broadly agrees that the development of new infrastructure, in the context of BRI, increases countries connectivity. However, it should be noted that most of the countries participating in BRI are emerging and developing economies. Thus, the disempowering nature of social, cultural, economic, political, and institutional exclusion results in ineffective and non-transparent processes, that hamper the ability of states to extract gains from BRI projects. Therefore, for some countries, the negative effects of economic corridors are likely to outweigh the real benefits of new infrastructure. As in our sample the selected European countries are more developing than developed, the overall effect of economic corridors on their logistics performance is statistically significant, but negative.

The institutional effect of economic corridors on logistics performance which was modelled using interaction between dummy variable BRI and Government effectiveness index GE is statistically significant and positive. Estimated effects of the variables on LPI (and LPI indicators) and their statistical significance are consistent across all estimations. Thus we can confirm that better institutional quality in BRI countries leads to higher levels of logistics performance. Also, the Table 3 shows that the relationship between economic corridors and logistics performance vary (changes from negative to positive), depending on countries institutional quality. Visualisation of the estimations in Table 3 is presented in Fig. 2 where the simplified version of the conditional relationship between economic corridors and logistics performance for high and low levels of countries institutional quality in the sample are shown.

**Table 3.** The results of the nexus between economic corridors and logistics performance via institutional quality

Full variable name	Short variable name	Parameter	Fixed-effects estimates of Eq. (2) using robust standard errors (HAC)		
			LPIO as dependent variable	LPII as dependent variable	LPIC as dependent variable
Constant	Const	$\alpha$	5,173* (2,685)	4,903 (3,738)	5,873** (2,697)
Economic corridors	BRI	$\beta_1$	-0,1135* (0,05636)	-0,2651*** (0,08960)	-0,1568** (0,06280)
The Quality of Institutions	ln (GE)	$\beta_2$	0,1331 (0,09743)	-0,03508 (0,1383)	0,1817 (0,1455)
The Interaction between Economic corridors and The Quality of Institutions	BRI ln(GE)	$\beta_3$	0,1041** (0,04074)	0,2328*** (0,06977)	0,1571*** (0,05343)
Trade	ln (TR)	$c_1$	-8,094** (3,184)	-9,290*** (2,989)	-7,749*** (2,351)
GDP	ln(GDP)	$c_2$	0,05080 (0,1233)	0,2467 (0,1551)	0,03128 (0,1245)
Population Density	ln(PD)	$c_3$	-0,2016 (0,3298)	-0,4888* (0,2476)	-0,4357* (0,2494)
Foreign Direct Investment	ln (F)	$c_4$	-0,01230 (0,02536)	-0,03391 (0,02410)	-0,05583** (0,02126)
Investment	ln(I)	$c_5$	0,01023 (0,01798)	0,03570* (0,01988)	0,02646 (0,01693)
Labor Force	ln(L)	$c_6$	0,2176 (0,2129)	0,06309 (0,2334)	0,2326 (0,1894)
Human Development Index	ln (HDI)	$c_7$	-0,9372 (0,6994)	-0,8687 (0,9125)	-1,638** (0,7906)
Time Dummies		$\theta_t$	YES	YES	YES
Number of observations		n	211	211	211
Within R <sup>2</sup>			0,4194	0,4353	0,3953
<b>Panel Diagnostics:</b>					
Wald test for heteroskedasticity <sup>a</sup>			7833,91 [0]	2985,46 [0]	1168,6 [0]
Wooldridge test for autocorrelation in panel data <sup>b</sup>			1,38418 [0,2473]	0,272057 [0,6053]	0,0476519 [0,8285]
Pesaran CD test <sup>c</sup>			-1,341 [0,1799]	-1,1508 [0,2498]	-1,14826 [0,250863]
Wald joint test on time dummies <sup>d</sup>			0,697232 [0,6264]	0,940543 [0,4569]	2,06112 [0,0739]

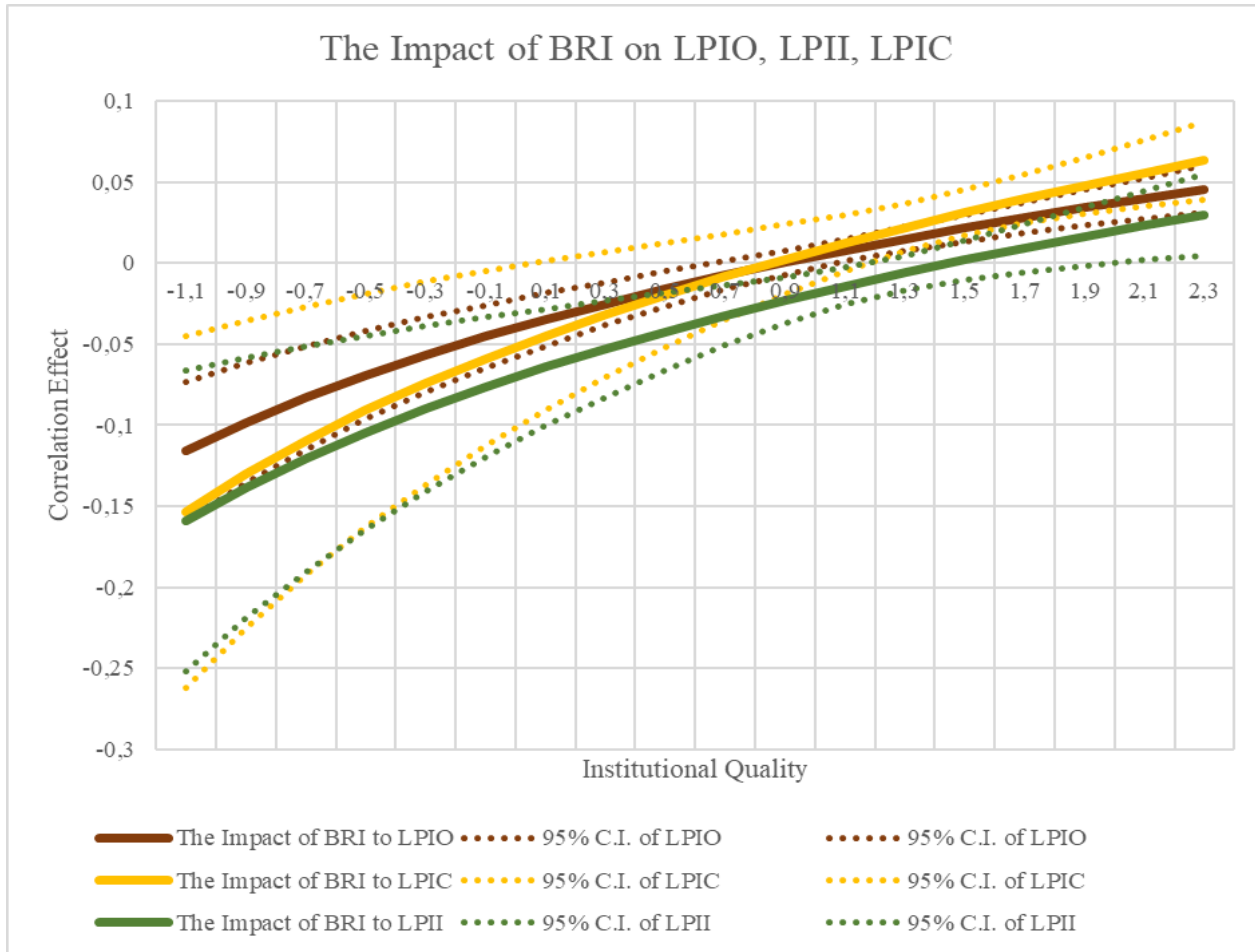
Notes: Robust (HAC) standard errors presented in parentheses. P-values presented in the square brackets. \*, \*\*, \*\*\* indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

<sup>a</sup> p-value < 0.05 counts against the null hypothesis: the units have a common error variance;

<sup>b</sup> p-value < 0.05 counts against the null hypothesis: no first-order autocorrelation;

<sup>c</sup> p-value < 0.05 counts against the null hypothesis: no cross-sectional dependence;

<sup>d</sup> p-value < 0.05 counts against the null hypothesis: no time effects.



Note: The thick solid line shows the conditional point estimates of economic corridors – institutional quality nexus. The thin lines in round dots shows the conditional 95% C.I. of the point estimate  $\pm 1.96 S_{(\beta_1 + \beta_2 GE)}$  (S is calculated using Eq (4)).

**Fig. 2.** Meaningful marginal effects and confidence intervals of the nexus between economic corridors, logistics performance and institutional quality.

For overall logistics performance index (LPIO) the negative and statistically insignificant impact of economic corridors appears in countries with an extremely low institutional quality (range from -1,1 to 0,3). The positive but still statistically insignificant impact of economic corridors on overall logistics performance index occurs in countries whose institutional quality is in the range from 0,5 to 1,5. Positive and statistically significant effects of economic corridors on LPIO only occur when the institutional quality of countries, i.e. The government efficiency index is in the range from 1,7 to 2,3.

For Logistics performance index customs indicator (LPIC) the negative and statistically significant impact of economic corridors appears in countries with an extremely low institutional quality (range from -1,1 to -0,9). The negative and statistically insignificant impact of economic corridors appears in countries with institutional quality that range from -0,7 to 0,1). The positive but still statistically insignificant impact of economic corridors on Logistics performance index customs indicator occurs in countries whose institutional quality is in the range from

0,3 to 0,9. Positive and statistically significant effects of economic corridors on LPIC occurs in countries with institutional quality from 1,1 to 2,3.

For Logistics performance index infrastructure indicator (LPII) the the negative and statistically significant impact of economic corridors appears in countries with an extremely low institutional quality (range from -1,1 to -0,3). The negative and statistically insignificant impact of economic corridors appears in countries with institutional quality that range from -0,1 to 0,5).

The results confirm that with the improvement of institutional quality the impact of economic corridors of logistics performance is increasing and from negative becomes possitive. Insitutional quality is a significant mediator in a relationship between economic corridors and logistics performance. Thus better institutions may inlist grater impact of economic corridors which protmote the growth of the level of logistics performance in a country.

#### 4.2. Robustness Check

To ensure that our general estimates are robust we perform a series of robustness check. *Firstly*, we checked robustness by including additional control variables one by one in the general model (Table 4). The results showed that although the coefficient of estimates differ, the overall positive effect of the institutional environment remains unchanged. Secondly, to test weather institutional quality still has an effect on the relationship between economic corridors and logistics performance, instead of government effectiveness as the mediator we included alternative control for corruption estimator ( $\log[CC+2.5]$ ) (Table 5). Although the estimation did not show significant effects, however the result in general is the same, i.e. less corruption will lead to less negative or greater positive effect of economic corridors on countries logistics performance. In other word the changes of the effect of the economic corridors is corresponding to the countries institutional environment. The same results have been confirmed in resent reserch as well, that the low level of corruption and (or) the high level of political stability leads to better logistics performance in a country (Arvis et al., 2014; Seabra et al., 2016; Wong & Tang, 2018a).

For the last robustness check we changed the strategy of the estimation, simmilar to that as suggested by (Butkus & Seputiene, 2018) by alternatively using the time-varying dummies. We constructed the dummy for high governmet effectiveness  $HGE_{i,t}$ , which is equal to 1 if government effectiveness in country  $i$  during the period  $t$  is above the median 0,975 and 0 if otherwise. HGE varies in time  $t$ .

The results are consistent with the general model (Table 6). The impact of economic corridors in the group of countries with a relatively high institutional quality is positive and statistically significant. The impact of economic corridors in the group of countries with relatively low institutional quality is negative for LPIO and LPII and positive for LPIC, but statistically insignificant in general. The impact of economic corridors on logistics performance differs significantly between countries with relatively low and relatively high institutional quality ( $\beta_3$ ).

All estimations confirm that a better institutional quality of a country shapes the impact of economic corridors to logistics performance in a way that a stable institutions can foster the growth of the level of countries logistics. Thus, the results are robust to alternative estimation strategy, alternative proxy for institutional quality and inclusion of additional control variables.

**Table 4.** The estimation of the impact of economic corridors on logistics performance with additional variables added

Full variable name	Short variable name	Parameter	Fixed-effects estimates of Eq. (2) using robust standard errors (HAC) with LPIO as dependant variable						
			(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	Const	$\alpha$	8,756*** (3,013)	8,451*** (2,145)	8,474*** (2,202)	8,752*** (2,371)	8,658*** (2,286)	7,385** (2,735)	5,173* (2,685)
Economic corridors	BRIdj	$\beta_1$	-0,1179* (0,06164)	-0,1183* (0,06376)	-0,1177* (0,06361)	-0,1154* (0,06124)	-0,1176* (0,06079)	-0,1291* (0,06373)	-0,1135* (0,05636)
The Quality of Institutions	ln (GE)	$\beta_2$	0,09159 (0,08496)	0,09002 (0,08774)	0,09514 (0,1012)	0,1098 (0,1019)	0,1097 (0,1027)	0,1294 (0,1018)	0,1331 (0,09743)
The Interaction between Economic corridors and The Quality of Institutions	BRIdj ln(GE)	$\beta_3$	0,1065** (0,04416)	0,1067** (0,04541)	0,1067** (0,04558)	0,1043** (0,04388)	0,1063** (0,04369)	0,1158** (0,04541)	0,1041** (0,04074)
Trade	ln (TR)	$c_1$	-7,688** (2,986)	-7,706** (3,055)	-7,748** (3,150)	-7,908** (3,181)	-7,842** (3,174)	-7,812** (3,214)	-8,094** (3,184)
GDP	ln(GDP)	$c_2$		0,01269 (0,07838)	0,009568 (0,08321)	0,005558 (0,08138)	0,005419 (0,08131)	-0,03350 (0,09934)	0,05080 (0,1233)
Population Density	ln(PD)	$c_3$			0,02107 (0,2143)	0,02479 (0,2161)	0,02217 (0,2139)	-0,1585 (0,3304)	-0,2016 (0,3298)
Foreign Direct Investment	ln (F)	$c_4$				-0,01231 (0,02453)	-0,01239 (0,02475)	-0,01079 (0,02495)	-0,01230 (0,02536)
Investment	ln(I)	$c_5$					0,003874 (0,01755)	0,005477 (0,01588)	0,01023 (0,01798)
Labor Force	ln(L)	$c_6$						0,1973 (0,2168)	0,2176 (0,2129)
Human Development Index	ln (HDI)	$c_7$							-0,9372 (0,6994)
Time Dummies		$\theta_t$	YES	YES	YES	YES	YES	YES	YES
Number of observations		n	211	211	211	211	211	211	211
Within R <sup>2</sup>			0,4033	0,4034	0,4035	0,4060	0,4062	0,4105	0,4194
<b>Panel diagnostics:</b>									
Wald test for heteroskedasticity <sup>a</sup>			9731,1 [0]	9488,89 [0]	9556,06 [0]	10508,8 [0]	9119,51 [0]	12401,2 [0]	7833,91 [0]
Wooldridge test for autocorrelation in panel data <sup>b</sup>			1,26644 [0,2680]	1,10944 [0,2994]	0,93998 [0,3389]	0,954679 [0,3352]	1,06238 [0,3097]	1,10672 [0,3000]	1,38418 [0,2473]
Pesaran CD test <sup>c</sup>			-1,31553 [0,1883]	-1,31805 [0,1874]	-1,31261 [0,1893]	-1,28504 [0,1987]	-1,29917 [0,1938]	-1,40682 [0,1594]	-1,341 [0,1799]
Wald joint test on time dummies <sup>d</sup>			1,30158 [0,2656]	1,27836 [0,2756]	1,08825 [0,3688]	1,08396 [0,3712]	1,08691 [0,3696]	0,964532 [0,4413]	0,697232 [0,6264]

Notes: Robust (HAC) standard errors presented in parentheses. P-values presented in the square brackets. \*, \*\*, \*\*\* indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

<sup>a</sup> p-value < 0.05 counts against the null hypothesis: the units have a common error variance;

<sup>b</sup> p-value < 0.05 counts against the null hypothesis: no first-order autocorrelation;

<sup>c</sup> p-value < 0.05 counts against the null hypothesis: no cross-sectional dependence;

<sup>d</sup> p-value < 0.05 counts against the null hypothesis: no time effects.

**Table 5.** The impact of economic corridors on logistics performance with control of corruption as alternative mediator

Full variable name	Short variable name	Parameter	Fixed-effects estimates of Eq. (2) using robust standard errors (HAC)		
			LPIO as dependent variable	LPII as dependent variable	LPIC as dependent variable
Constant	Const	$\alpha$	5,592* (2,859)	5,131 (3,805)	6,350** (2,671)
Economic corridors	BRIdj	$\beta_1$	-0,07666 (0,05529)	-0,1791*** (0,06025)	-0,09679 (0,06448)
The Quality of Institutions	ln (CC)	$\beta_2$	0,03244 (0,08783)	-0,01419 (0,09051)	0,008077 (0,09808)
The Interaction between Economic corridors and The Quality of Institutions	BRIdj ln(CC)	$\beta_3$	0,07386* (0,04137)	0,1639*** (0,04529)	0,1079* (0,05642)
Trade	ln (TR)	$c_1$	-8,064** (3,266)	-9,388*** (2,984)	-7,643*** (2,474)
GDP	ln(GDP)	$c_2$	0,05419 (0,1170)	0,2204 (0,1599)	0,04812 (0,1129)
Population Density	ln(PD)	$c_3$	-0,2812 (0,3246)	-0,5576** (0,2546)	-0,5536** (0,2439)
Foreign Direct Investment	ln (F)	$c_4$	-0,009822 (0,02493)	-0,03598 (0,02584)	-0,05237** (0,02085)
Investment	ln(I)	$c_5$	0,01163 (0,01749)	0,03788* (0,01900)	0,02787 (0,01704)
Labor Force	ln(L)	$c_6$	0,2124 (0,2011)	0,1175 (0,2307)	0,2121 (0,2006)
Human Development Index	ln (HDI)	$c_7$	-0,8644 (0,7326)	-0,8576 (0,9583)	-1,575* (0,7777)
Time Dummies		$\theta_t$	TAIP	TAIP	TAIP
Number of observations		n	211	211	211
Within R <sup>2</sup>			0,4141	0,4304	0,3953
<b>Panel diagnostics:</b>					
Wald test for heteroskedasticity <sup>a</sup>			5140,42 [0]	1786,77 [0]	1757,36 [0]
Wooldridge test for autocorrelation in panel data <sup>b</sup>			2,14497 [0,1519]	0,544583 [0,4654]	0,285021 [0,5968]
Pesaran CD test <sup>c</sup>			-1,24879 [0,2117]	-1,28611 [0,1984]	-1,144280 [0,253]
Wald joint test on time dummies <sup>d</sup>			1,61177 [0,1598]	2,65294 [0,0247]	3,07912 [0,0110]

Notes: Robust (HAC) standard errors presented in parentheses. P-values presented in the square brackets. \*, \*\*, \*\*\* indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

<sup>a</sup> p-value < 0.05 counts against the null hypothesis: the units have a common error variance.

<sup>b</sup> p-value < 0.05 counts against the null hypothesis: no first-order autocorrelation.

<sup>c</sup> p-value < 0.05 counts against the null hypothesis: no cross-sectional dependence.

<sup>d</sup> p-value < 0.05 counts against the null hypothesis: no time effects.

**Table 6.** The impact of economic corridors in the group of countries with a relatively high institutional quality

Full variable name	Short variable name	Parameter	Fixed-effects estimates of Eq. (2) using robust standard errors (HAC)		
			LPIO as dependent variable	LPII as dependent variable	LPIC as dependent variable
Constant	Const	A	5,773** (2,738)	5,296 (3,612)	6,737** (2,578)
Economic corridors	BRIdj	$\beta_1$	-0,01339 (0,02402)	-0,02564 (0,02886)	0,0007791 (0,02100)
The Quality of Institutions	HGE	$\beta_2$	-0,01781 (0,01662)	-0,01350 (0,02158)	-0,03389* (0,01879)
The Interaction between Economic corridors and The Quality of Institutions	BRIdjHGE	$\beta_3$	0,04762** (0,02221)	0,07675*** (0,02561)	0,05601** (0,02671)
Trade	ln (TR)	$c_1$	-8,191** (3,181)	-9,759*** (2,914)	-7,730*** (2,399)
GDP	ln(GDP)	$c_2$	0,07696 (0,1188)	0,2494 (0,1529)	0,07202 (0,1149)
Population Density	ln(PD)	$c_3$	-0,2487 (0,3076)	-0,3886 (0,2548)	-0,5067** (0,2162)
Foreign Direct Investment	ln (F)	$c_4$	-0,01082 (0,02429)	-0,03871 (0,02532)	-0,05552*** (0,02029)
Investment	ln(I)	$c_5$	0,007212 (0,01764)	0,02645 (0,01715)	0,02194 (0,01702)
Labor Force	ln(L)	$c_6$	0,1676 (0,2121)	0,04095 (0,2180)	0,1452 (0,1801)
Human Development Index	ln (HDI)	$c_7$	-0,8478 (0,6503)	-0,9189 (0,8575)	-1,566** (0,7358)
Time Dummies		$\theta_t$	YES	YES	YES
Number of observations		n	211	211	211
Within R <sup>2</sup>			0,4203	0,3879	0,4258
<b>Panel diagnostics:</b>					
Wald test for heteroskedasticity <sup>a</sup>			4135,2 [0]	1391,2 [<0.0001]	1976,16 [0]
Wooldridge test for autocorrelation in panel data <sup>b</sup>			1,77777 [0,1910]	0,206433 [0,6523]	0,190077 [0,5968]
Pesaran CD test <sup>c</sup>			-1,23106 [0,2183]	-1,26571 [0,2056]	-1,144280 [0,253]
Wald joint test on time dummies <sup>d</sup>			1,68076 [0,1421]	2,78367 [0,0193]	3,29371 [0,0073]
H0: $\beta_1 + \beta_3 = 0$			0,05111 <sup>e</sup> [0,0144]	0,03423 <sup>e</sup> [0,0107]	0,0567891 <sup>e</sup> [0,0334]

Notes: Robust (HAC) standard errors presented in parentheses. P-values presented in the square brackets. \*, \*\*, \*\*\* indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

<sup>a</sup> p-value < 0.05 counts against the null hypothesis: the units have a common error variance;

<sup>b</sup> p-value < 0.05 counts against the null hypothesis: no first-order autocorrelation;

<sup>c</sup> p-value < 0.05 counts against the null hypothesis: no cross-sectional dependence;

<sup>d</sup> p-value < 0.05 counts against the null hypothesis: no time effects.

<sup>e</sup> value presents the sum of coefficients  $\beta_1$  and  $\beta_2$ .

#### **4.3. Limitations and future research directions**

This study introduces the multiplicative approach to analyse determinants of logistics performance – economic corridor nexus in the context of moderating role of institutional quality. However, several limitations need to be acknowledged.

The first one is related to the availability of the data as BRI was introduced only recently, limiting the length of the analyzed period. Thus our estimations do not capture the most recent trends of the increasing impact of economic corridors. Secondly, no official or generally accepted definition of the BRI exists, thus it is very difficult to identify its geographical scope. Therefore, applying the same methodology for data, several years after the announcement of BRI, future research could include more countries and additional time periods to explore the matter in more detail.

Furthermore, this study analysed the moderating role of institutional quality through which economic corridors affects logistics performance of a country. Future research could include additional channels as FDI, political or legal environment of a country to explore the economic corridor – logistics performance nexus in more detail.

Despite the fact, our approach assumes that the initiative of economic corridors must be accompanied by strong and efficient institutions, which will ultimately lead to better logistics performance in the country.

#### **Conclusions**

This study has delved into a question of whether the relationship between economic corridors and logistics performance depends on different factors, what was done very scarcely in the literature. Therefore, this paper, while exploring the complex nature of economic corridors phenomenon, has aimed to fill this gap by providing new insights analysing the impact of economic corridors to countries logistics performance via institutional effect. It has explored the extent to which institutions in Europe, inherited either from Eastern or Western governance cultures, affects the impact of economic corridors to logistics performance of selected European countries.

The results of the analysis point to the fact that the impact of economic corridors to countries logistics performance is ambiguous. The meaningful marginal effect of the impact of economic corridors varies depending on the political culture of public governance in a particular country, which determines the effectiveness of institutional quality. Once a certain level of institutional quality is reached, the impact of economic corridors on countries logistics performance changes from negative to positive. This means that better institutions in the country, eases development of economic corridors in favor of the quality of logistics services. The results confirm that logistics is easier in BRI countries with better institutions. However, in countries with weak institutions logistics service providers are failing to make effective use of the infrastructure being developed in the context of economic corridors, due to entrenched traditions of political and institutional jurisdiction that are reluctant to changes.

There are two major contributions associated with this study. In theoretical aspect, the frontier of the knowledge of economic corridors is complemented with logistics performance and institutional quality with their associated theories such as The New economic geography and Institutional economics. Considering the economic corridors as a phenomenon of complex nature, this paper shows that the impact of economic corridors to logistics performance varies across the perceived level of institutional quality. However, this research is not without limitations. This research assumes that economic corridors should be further investigated including additional channels such as FDI, political or legal environment of a country to explore the economic corridor – logistics performance nexus in more detail.

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