The effects of transport infrastructure and logistics services on international trade and economic growth: the case of Central and Eastern European member states (CEMS)

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UČINCI TRANSPORTNE INFRASTRUKTURE I LOGISTIČKE USLUGE NA MEĐUNARODNU TRGOVINU I EKONOMSKI RAST: SLUČAJ ZEMALJA ČLANICA SREDNJE I ISTOČNE EUROPE (CEMS)

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DOCTORAL THESIS

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The doctoral thesis has been defended on March 11th 2022 at University of Rijeka, Faculty of Economics and Business, before the Committee of the following members:

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SUMMARY

The aim of this dissertation is to investigate the impact of transport infrastructure and logistics performance on international trade and economic growth in the Central and Eastern European Union Member States (CEMS). The dissertation is divided in three separate and interrelated research papers. In the first research paper, the question of the role of transport infrastructure in the economy is revisited through the construction of two empirical econometric models.

The first model estimates the impact of road and rail infrastructure on economic growth, considering population growth, investment in infrastructure and trade openness. The second model is used to check the robustness of the first model and follows the Aschauer's (1989) aggregate production function. The analysis is based on a panel data regression with fixed effects estimator (FE). The results of the first model show a significant and positive relationship between road infrastructure and economic output, and significant but negative relationship between rail infrastructure and economic output. The results of the estimation of aggregate production function suggest that among all types of infrastructure, only road transport infrastructure shows significant positive effects on economic output. Although overall results show inconclusive results, they should be seen in a broader context where transport infrastructure is a public good and investment in it is necessary to ensure the territorial, economic and social cohesion of CEMS countries. The second research paper examines the impact of logistics performance on bilateral trade of the EU15 and CEMS countries. The analysis is based on a structural gravity model estimated with the Poisson Pseudo-Maximum Likelihood Estimator (PPML). The results show that there is a significant relationship between logistics performance and EU15 and the CEMS bilateral trade, with heterogeneous effects of the elements of logistics performance on trade in different product groups.

The third research paper incorporates other elements of logistics performance and trade facilitation, i.e., hard and soft infrastructure, into international trade in addition to logistics performance. The aim is to assess the impact of trade facilitation, distinguishing between traditional trade and supply chain trade. In the first step, factor analysis is used to construct indicators of trade facilitation. In the second step, the effects of trade facilitation indicators on gross trade and trade value added data are estimated with the empirical model specification based on a structural gravity model. To address the issues of heteroscedasticity and zero trade values, the PPML estimator is also used. The results suggest that different elements of trade facilitation are significant and have different degrees of relevance to traditional and supply chain trade. The findings obtained in the dissertation contribute to the existing body of knowledge in this research area from a theoretical and applicative perspective and offer recommendations for potential improvements in the areas of transportation, logistics, and trade facilitation.

Keywords: transport infrastructure, logistics performance index, trade facilitation, bilateral trade, supply-chain trade, global value chains, economic growth, CEMS

SAŽETAK

Cilj ove disertacije je istražiti utjecaj transportne infrastrukture i logističke usluge na međunarodnu trgovinu i gospodarski rast u zemljama srednje i istočne Europe (CEMS), članicama Europske unije. Disertacija je podijeljena u tri zasebna i međusobno povezana znanstvena rada. U prvom istraživačkom radu se preispituje pitanje uloge transportne infrastrukture u gospodarstvu na temelju dva empirijska ekonometrijska modela. U prvom modelu se procjenjuju učinci cestovne i željezničke infrastrukture na gospodarski rast, kontrolirajući pritom rast stanovništva, ulaganja u infrastrukturu i otvorenost trgovine. Drugi se model koristi za provjeru robusnosti prvog modela i temelji se na agregatnoj proizvodnoj funkciji koju je koristio Aschauer (1989.) u svom radu. Analiza se temelji na regresiji panel podataka s procjeniteljem fiksnih učinaka (FE).

Rezultati prvog modela pokazuju značajnu i pozitivnu vezu između cestovne transportne infrastrukture i gospodarskog rasta, ali i značajnu negativnu vezu između željezničke infrastrukture i ekonomskog rasta. Rezultati procjene agregatne proizvodne funkcije ukazuju na to kako od svih promatranih vrsta transportne infrastrukture, jedino cestovna intrastruktura ima značajne pozitivne učinke na ekonomski rast, dok rezultati za ostale vrste infrastrukture nisu statistički značajni. Premda cjelokupni rezultati pokazuju nesignificantne rezultate, treba ih promatrati u širem kontekstu, jer je transportna infrastruktura javno dobro i ulaganje u nju potrebno je kako bi se ostvarila teritorijalna, ekonomska i socijalna kohezija zemalja CEMS. U drugom istraživačkom radu se analizira učinak logističkih performansi na bilateralnu trgovinu zemalja EU15 i CEMS. Analiza se temelji na strukturnom gravitacijskom modelu koji se procjenjuje s Procjeniteljem pseudo maksimalne vjerodostojnosti (PPML). Rezultati procjene pokazuju da postoji značajna veza između logističkih performansi bilateralne trgovine EU15 i CEMS zemalja, međutim različiti elementi logističkih performansi imaju različite učinke ovisno o grupama proizvoda kojima se trguje.

U trećem istraživačkom radu su uključeni i drugi elementi logističkih performansi, kao što je tvrda i meka infrastruktura, koja može imati učinke na međunarodnu trgovinu. Cilj trećeg rada jest procijeniti utjecaj tvrde i meke infrastrukture na tradicionalnu trgovinu i trgovinu kroz opskrbni lanac. Kako bi se konstruirale varijable olakšavanja trgovine, odnosno tvrde i meke infrastrukture, u prvom koraku analize se koristi faktorska analiza. U drugom koraku se koristi strukturni gravitacijski model kako s PPML procjeniteljem kako bi se procijenili učinci tvrde i meke infrastrukture na trgovinu. PPML procjenitelj se koristi kako bi se riješio problem heteroskedastičnosti i nula vrijednosti trgovine. Rezultati analize sugeriraju kako su različiti elementi olakšavanja trgovine, odnosno tvrda i meka infrastruktura značajni i da imaju različite stupnjeve relevantnosti za tradicionalnu trgovinu i trgovinu u lancu opskrbe. Rezultati disertacije doprinose postojećem znanju u području istraživanja iz teorijske i aplikativne perspektive i nude preporuke za moguća poboljšanja u područjima prometa, logistike, olakšavanja trgovine i gospodarskog rasta.

Ključne riječi: transportna infrastruktura, indeks logističkih performansi, olakšavanje trgovine, bilateralna trgovina, trgovina u lancu opskrbe, globalni lanci vrijednosti, ekonomski rast, CEMS

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1. INTRODUCTION

It is widely accepted that there is a strong link between infrastructure, trade and economic growth. This belief that transport infrastructure plays an important role in economic growth and development is not restricted to political circles but comes from economic theory. Although one might think that the economic analysis of transport infrastructure is relatively new, it goes back to the economic thinking of the second half of the 18th century (Button 2006).
For example, Adam Smith (1776) argued about the importance of transport infrastructure in his popular work 'An Enquiry into the Nature and Causes of the Wealth of Nations', pointing out that infrastructure is of public interest, that it can reduce development disparities between developed and underdeveloped areas, and that the government should invest in it. And indeed, transport infrastructure is a public good and therefore a part of public policy. Therefore, governments are expected to invest in its construction and revitalization.

With respect to transport infrastructure, Keynesians held that causality runs in a different direction, i.e. that economic growth generates investment in transport infrastructure, while neoclassical economists considered infrastructure as part of the aggregate production function. Many research papers followed this approach, with Aschauer (1989) being the seminal paper, and provided statistically significant evidence of the impact of transport infrastructure on economic growth (Munnell 1990; Biehl 1991; Holtz-Eakin 1992; Canning 1999; Cantos, Gumbau-Albert and Maudos 2005; Calderón, Moral-Benito and Servén 2015).

The hypothesis of positive effects of transport infrastructure on economic growth has also been the subject of various critiques arguing that the aggregate production function approach lacks theoretical and empirical foundations (Gramlich 1994; Button 1998). One problem is the direction of causality, as there is evidence showing that economic growth causes the need for investment in infrastructure and not vice versa (Vanhoudt et al. 2000). Transport allows movement in both directions, which means that in some cases transport infrastructure displaces people and sources to the core rather than bringing the periphery closer to the core, leaving the periphery in an even worse position (Button 2006). Some results show that transport infrastructure does not promote growth in the long run, but rather has short-term effects (Crescenzi and Rodríguez-Pose 2012). On the other hand, Pradhan (2019) confirms the positive effects of transport infrastructure on economic growth in a long run in G-20 countries. Despite these contradictory findings, infrastructure is considered by policy makers as an engine of economic growth. The importance of transport infrastructure for economic growth is mostly discussed in terms of its contribution to facilitating trade, movement of people, territorial cohesion and spatial connectivity. Transport infrastructure facilitates the flow of people, goods and information through space, and the development of spatial connectivity provides access to places where its capabilities can be put to productive use. Transport infrastructure is one of the pillars of growth and cohesion policy in the European Union. European policy makers see transport infrastructure as a tool to reduce disparities between old and new Member States, i.e. between the EU15 and the Central and Eastern EU Member States, by creating jobs, reducing transport costs, facilitating trade, improving access to resources, etc. The EU initiative Trans-European Networks is a good example as it is motivated by political cohesion. In addition, international organizations such as the World Bank also support investment in transport infrastructure worldwide, particularly in the context of reducing disparities between developed and developing countries. Finally, from a macroeconomic point of view, the growth effects of transport infrastructure remain inconclusive and the question arises as to the justification for such substantial expenditure on transport infrastructure, particularly in the Central and Eastern EU Member States.

In addition to transport infrastructure, logistics service is also gaining increasing interest among academics and policy makers. Without transport infrastructure and an efficient logistics service, global trade and the movement of goods around the world would not be possible. Logistics refers to a network of activities necessary to enable the physical movement of goods and cross-border trade. These activities go beyond transportation and include transshipment, warehousing, packaging, terminal operations, and the data and information management required for shipment tracking and timely delivery (Arvis et al. 2018). All these activities are responsible for promoting international trade and hence economic growth, more so than transport infrastructure itself.

Logistics activities are also closely linked to customs procedures and transport and trade regulations. This means that the efficient movement of goods from origin to destination requires an institutional framework that supports, rather than hinders, the smooth movement of goods. In practice, traders and logistics companies usually have to deal with extensive customs procedures and a large number of transport and trade documents. Considering that a single product usually crosses borders several times before becoming a final product, and given the complexity of cross-border trade, usually referred to as trade through supply chains or global value chains (Baldwin and Lopez-Gonzales 2015) and mostly consisting of parts and components (Grossman and Rossi-Hansberg 2008), efficient infrastructures and logistics activities combined with institutional frameworks are even more important.

The process of trade liberalization, reduction of traditional tariff barriers and the proliferation of free trade agreements have boosted trade within the supply chain, and now more attention is being paid to non-tariff barriers that affect the volume of cross-border trade. Therefore, reducing these trade barriers and improving trade facilitation is one of the most important issues in today's global economy. Hoekman and Shepherd (2013) note that trade facilitation has "a variety of contextual meanings" because there is no standard definition of trade facilitation and different institutions describe it differently. In this dissertation, we use the term trade facilitation to refer to the measures that can be implemented in two areas: hard infrastructure, which refers to physical infrastructure such as roads, rails, airports, seaports, and information and communication technology (ICT); and soft, non-physical infrastructure, which refers to transparency, policies, rules, regulations, the business environment, and other institutional aspects that are intangible (Portugal-Perez and Wilson 2012).

Efficient physical and ICT infrastructure, as well as soft infrastructure at borders and in institutions, is particularly important for small open economies such as most CEMS countries that specialize in producing a particular part or component of the final product and diversify their exports. Greater participation in global value chains and engagement in supply chain trade allows for diversification of exports and gaining competitive advantage in accessing larger markets, which is critical for sustainable economic growth and development.

1.2. PROBLEMS, OBJECTIVES AND HYPOTHESES OF THE RESEARCH

This dissertation addresses three separate and interrelated research problems. The first research problem is the relationship between transport infrastructure and economic growth. Scholars have studied the relationship between transport infrastructure and economic growth for decades, but the theoretical and empirical literature on the economic impact of transportation infrastructure remains inconclusive, with mixed results from various analyses. From the perspective of economic decision makers, questions arise about the justification for such decisions and the direction of investment in transportation infrastructure. These questions constitute one of research motives for this dissertation. In order to contribute to this issue, this dissertation re-examines the question of the impact of transport infrastructure on economic growth from the perspective of small open economies in Central and Eastern EU (hereafter CEMS). In particular, this question is of considerable importance for CEMS countries, as their growth and development depend to a large extent on investments in transport infrastructure and the establishment and expansion of Trans-European Transport networks (TEN-T).

This dissertation is not only concerned with transport infrastructure, but also with transport-related activities such as various logistics activities that affect international trade and hence economic growth. The CEMS countries have enormous logistics potential that has not yet been fully exploited. The CEMS countries are strategically located near the economically strongest countries such as Germany and France and together form the "Factory Europe", i.e. the huge, vibrant markets that drive intercontinental trade, especially between Asia and Europe. To promote the improvement of logistics performance, there should be more cross-modal, cross-geographical and cross-level cooperation between government and the private sector. Logistics activities are mainly carried out by private logistics providers and traders, but logistics is very important in shaping national and international economic policies.

Logistics related areas such as customs procedures, infrastructure and quality of logistics services are mainly the responsibility of the public sector and serve as inputs for the creation of logistics products (outputs) such as tracking of the shipment, timely delivery of the shipment or easy organisation of shipments at competitive prices, which are the responsibility of the private sector.

This argument has been a motivation for further research in this dissertation, which examines the impact of the various logistics activities that make up logistics performance on international trade in different product groups. Indeed, each country trades in different product groups and therefore there is a need to improve the elements of logistics that can help countries trade in a particular product or even integrate into the supply chain of that product. These findings are relevant at both macroeconomic and microeconomic levels, as logistics performance is a collective product of economic agents at both levels, namely governments and policy makers, but also companies involved in logistics, the supply chain and trade in general.

Along with the effects transport infrastructure and logistics performance, border and institutions efficiency have a critical role in facilitating international trade, particularly global value chains. In the empirical literature various indicators are used as a trade facilitation measures, such as World Bank's Doing Business indicators or the World Bank's Logistics Performance Indicators, however none of the empirical analyses encompasses all those aspects of trade facilitation. Moreover, there is a gap in the literature regarding the effects of trade facilitation on supply chain trade, which makes approximately two thirds of today's trade. The complexity of supply chain trade requires adequate physical infrastructure such as roads, rails, ports, telecommunications that will enable physical movement of goods and also soft, non-physical infrastructure that support all trade related processes and organization of it. Supply chain trade can be of great benefit to the CEMS economies by facilitating entry into the market of new types of products and providing a comparative advantage in the production of certain products. Firms can specialize in certain activities and tasks in which they are competitive by participating in global value chains. Trade facilitation has an impact on reducing the fixed costs of participating in supply chain trade, which is a major barrier to internationalization, especially for small firms, which are prevalent in the CEMS. Therefore, another objective of this dissertation is to address, on the one hand, the issue of measuring trade facilitation by including different indicators covering all aspects of trade facilitation and, on the other hand, to assess the impact of trade facilitation on traditional trade and provide complementary insights specifically for supply chain trade.

In line with the problems and objectives of the research, the main research hypotheses of this doctoral dissertation are as follows:

H1: Considering the effects of the past investment flows in transport infrastructure in the Central and Eastern European EU Member States, it can be assumed that infrastructure has a significant impact on economic growth, with different types of infrastructure being of varying importance.

H2: Logistics performance is expected to have a positive impact on bilateral trade in the case of Central and Eastern EU Member States, but this effect may vary for trade in specific product groups.

H3: It is expected that trade facilitation has positive impact on both traditional trade and supply-chain trade, however different trade facilitation elements (improvement in hard and soft infrastructure) bear different degree of relevance for traditional and supply chain trade.

In order to address the defined problems and objects of the research, test the research hypotheses and achieve the research goal, it is necessary to provide scientific answers to several research questions, the most important of which are:

1. Does transport infrastructure affect economic growth in Central and Eastern Europe and are these effects the same for different types of transport infrastructure?

2. Does logistics performance affect international trade and if so, in what direction?

3. Is logistics performance equally important for trade in different product groups?

4. How do different components of logistics performance affect trade in different product groups?

5. Does trade facilitation i.e. hard and soft infrastructure have significant impact on traditional trade and does it have significant impact on supply chain trade?

6. Are there differences in the impact of hard and soft infrastructure on traditional trade as opposed to supply chain trade?

1.3. SCIENTIFIC METHODS

This dissertation uses several scientific methods that come from different sources. The research is divided into three separate research papers and the scientific methods are applied to the specific research problems. The first research paper in this dissertation estimates the impact of transportation infrastructure on economic growth. The research is based on a panel data analysis for a sample of eleven EU Member States (Central and Eastern Europe) in the period from 1995 to 2016, taken from the Eurostat database (2017). We first developed a model that included five independent variables, namely population, infrastructure investment, trade openness, rail transport infrastructure and road transport infrastructure, and a dependent variable, output level (measured with gross domestic product). The model is estimated using the fixed effects estimator (FE). As a robustness check of the first model, we estimate aggregate production model by following the approach of Aschauer (1989), which we modified with respect to our research area. The independent variables used in the second model are real GDP on the output side at chained PPPs, number of employed persons (in millions), average annual hours worked by employed persons and capital stock at current PPPs (in millions 2017 USD), and rail and road infrastructure, while the dependent variable is economic growth (annual % change of GDP). The data for the analysis are obtained from Penn World Tables (2021), version 10, while data on transport infrastructure, road and rail, are from Eurostat Database (2017).

The second research paper in this dissertation estimates the impact of logistics performance on international (bilateral) trade. Our data consist of bilateral trade data between the EU28 member countries and their trading partners, 157 countries in total. Within the EU28 countries, we distinguish between two groups: new EU member countries, i.e. all countries that became EU members in 2004 (CEMS) and old EU member countries (EU15). The third group of countries are third countries referred to as the rest of the world (ROW). The economic model contains five independed variables; size of the economy measured by GDP, distance between trading partners, logistics performance as measured by six sub-indices, and a number of dummy variables commonly included in the gravity model, such as contiguity and the presence of a common language between trading partners. As a depended variable is used the value bilateral trade between trading partners. The source for bilateral trade data comes from the UN Comtrade database (2019). We obtained GDP data from World Bank Open Data (2019), while we obtained data for other standard variables from the CEPII database (2019). Data for our main variable of interest, the LPI sub-indices, comes from the World Bank.

The third research paper of this dissertation estimates the impact of hard and soft infrastructure on traditional trade and supply chain trade. Our data include bilateral trade data between 130 reporting countries and 131 partner countries and cover the period from 2000 to 2019. Data for traditional trade come from the UN Comtrade database (2020), while data for supply chain trade come from the Eora MRIO (2020) database. Other variables in the model such as gross domestic product (GDP) data, free trade agreement data, and distance data are from the CEPII database (2019). Hard and soft infrastructure variables (trade facilitation indicators) come from the World Economic Forum - Global Competitiveness Report (2020), the Worldwide Governance Indicators (2020) and the World Bank Doing Business (2020) database. The original data sample (hard and soft infrastructure) included 16 indicators. However, Confirmatory Factor Analysis was used to create four aggregated "synthetic" indicators representing hard and soft infrastructure variables: physical infrastructure, ICT infrastructure, institutional efficiency, and border efficiency. The theoretical frameworks of second and third research papers of dissertation are based on the theory of the gravity model of international trade developed by Tinbergen (1962). We develop a structural gravity model that uses differences in trading partner variables as regressors. In addition, fixed effects for exporters and importers are used in the estimations, as suggested by Anderson and van Wincoop (2004) and Baldwin and Taglioni (2006), as they eliminate possible biases in the estimation results. To address the issue of heteroscedasticity and zero trade values, the estimator used is Poisson Pseudo-Maximum-Likelihood Estimator (PPML), which was first introduced by Santos Silva and Tenreyro (2006) in gravity model setting.

1.4. STRUCTURE OF THE DISSERTATION

This dissertation is written in the form of three research papers. The structure of the dissertation follows the structure of three papers, each of them being a separate chapter.

In the introduction, the research area is described, problems, objectives and hypotheses of the research are defined, and the scientific methods used to achieve the research objective are explained. After the introduction, the second part of dissertation entitled "The macroeconomic effects of transport infrastructure on economic growth: the case of the Central and Eastern EU Member States (CEMS)", deals with the impact of road and rail transport infrastructure on economic growth in eleven CEMS countries and provides insights into the relationship between transport infrastructure and economic growth today. This part discusses the issues in the CEMS countries in relation to sustainable economic growth objectives. This part consists of six sections, the introductory section, the theoretical background, and literature review on the relationship between transport infrastructure and economic growth, the description of the data used for the analysis, the methodology of the study explaining the two estimated models, the discussion of the research findings and finally the concluding remarks.

The third part of the dissertation entitled "The effects of logistics performance on international trade: EU15 vs CEMS" analyses the effects of six different components of logistics performance on trade in different product groups. In addition, this part examines how logistics performance affects bilateral trade flows, comparing the effects between two groups of countries within the same economic integration, namely EU15 and CEMS. This part is divided into six sections, the introduction, the literature review on the relationship between logistics performance and international trade, the methodology in the context of gravity model theory, the presentation of data and variables, the discussion of the research findings and policy implications and ends with concluding remarks.

The fourth part of the dissertation, entitled "Assessing the effects of hard and soft infrastructure on traditional vs supply-chain trade: the case of Central and Eastern EU member states (CEMS)" examines the effects of trade facilitation on two types of trade, traditional trade and supply-chain trade. The fourth part consists of six sections, the introduction, the literature review on trade facilitation, the description of the methodological specification of the gravity model, the presentation of the data and variables used in the analysis, the presentation of the research results and the conclusion.

The fifth part of the dissertation provides concluding remarks, highlights policy implications and refers to the main theoretical and applied contribution of the research.

1.5. EXPECTED CONTRIBUTION

It is expected that the results of the dissertation will make several theoretical and applied contributions to the existing body of knowledge. The dissertation tests the effects of transport infrastructure using various estimation approaches and revisits the question of the importance of the impact of transport infrastructure on economic growth in Central and Eastern European member states. From an economic and trade policy perspective, the dissertation supports the viewpoint that road infrastructure plays an important role in economic growth. However, the results also show that other types of infrastructure are not solely important in promoting economic growth and that other factors should be considered that can contribute to economic growth and trade in Central and Eastern Europe. Moreover, no previous study has examined how differences in various aspects of logistics performance affect trade. This study highlights the importance of logistics services in international trade for different product groups, distinguishing between two groups of countries within economic integration, namely the EU.

From an applicative perspective, the research findings shed light on the importance of each logistics element (such as infrastructure, customs, tracking, timely delivery etc.) for trade in a particular product group, which is important for countries that want to diversify their production and participate in global value chains. It is expected that this dissertation will contribute to the trade facilitation literature from the perspective of traditional and supply chain trade. The results of the analysis give the insights into the specific elements of trade facilitation (hard and soft infrastructure) that are responsible for trade growth. This is the first study to differentiate the impact of trade facilitation for different types of trade, namely traditional and supply chain trade. The focus of this dissertation is on trade gains in the case of central and Eastern European Countries, which stand to benefit from greater participation in the global value chain. This dissertation provides information for the creation of trade facilitation policies and strategies that can benefit CEMS countries and their participation in regional and global value chains. These research findings provide guidance to policy makers on what elements of trade facilitation they should rely on to improve trade within the supply chain.

2. THE MACROECONOMIC EFFECTS OF TRANSPORT INFRASTRUCTURE ON ECONOMIC GROWTH: THE CASE OF CENTRAL AND EASTERN EU MEMBER STATES (CEMS)

Abstract

This paper empirically investigates the effects of transport infrastructure on economic growth in Central and Eastern EU Member States (CEMS) in the period 1995–2016. During the transition period in CEMS, most investments were focused on the roads, while rails have been lagging for decades. The aim of this paper is to estimate the effects of transport infrastructure (road and rail) on economic growth while controlling with other variables such as population, gross fixed capital formation and trade openness. As a robustness check of our original model, we employ Aschauer's (1989) aggregate production function, that we modified considering our research area. The results of the first model show positive effects on economic growth in case of all estimated variables, except the railway infrastructure where the effects seem to be negative and illustrate the long-standing problem of inefficient and outdated railway infrastructure. The results of the aggregate production function model show that transport infrastructure estimates are insignificant for economic output except in case of road infrastructure. These results should be seen in a broader context, especially in the light of the ongoing desire to reduce CO_2 emissions that are to a large extent produced by road transport, while railway transport is more environmentally friendly. The results also imply that transport infrastructure alone is not always sufficient to achieve higher levels of growth and that other factors should be also taken into consideration.

Keywords: transport infrastructure, economic growth, aggregate production function, panel analysis, fixed effects, CEMS countries

JEL classification: E60, R42, R48

2.1. INTRODUCTION

Transport and related infrastructure have played a pivotal role in economic growth and development during the last century, and many theoretical and empirical studies have recognized it as an important factor in maintaining and promoting economic growth. Transport infrastructure may be the prerequisite for economic development, while transport and the supporting infrastructure network can be an engine in promoting economic growth. Transport capacities are especially important in the case of small open economies such as Croatia and most Central and Eastern EU Member States (CEMS), where an efficient transport system allows for an increase in international trade and thus stimulates economic growth. The share of transportation in the gross domestic product of developed countries accounts for approximately 6–12%. It is considered that today, in the era of globalization, the competitive advantage of each economy depends, inter alia, on facilitating more efficient transport of people and goods, while the key obstacle can be the lack of efficient and high-quality transport infrastructure.

During the transition period, in particular since the beginning of the 1990s, insufficient investments have been made on railways and railway infrastructure in the CEMS, leading to the obsolescence of the transport sector and prioritization of road transport over the railway. In the last few decades the transport sector has grown dramatically in the European Union (EU), with the main increase seen in road transport (European Commission, 2012 in Bonča, Udovč and Rodela 2017). EU investments in transport infrastructure are one of key, if not the key, mechanisms that can increase economic development and convergence (Crescenzi and Rodríguez-Pose 2012). The main problems of the rail system of most CEMS countries include the poor state of infrastructure and fleet, problems that reflect the cargo and passenger transport activities, the lack of efficient rail links with maritime and river ports, and insufficient integration of the national network into the European transport network, which prevents the implementation of system interoperability. Even though pre-accession EU funding investments have enhanced connectivity and accessibility in these countries considerably, transportation by rail lags far behind (European Parliament, 2016).

Considering that transport and related infrastructure are of national and strategic interest for each country, we revisit the question by looking at the impact of transport infrastructure, proxied by kilometres of motorways and kilometres of railways, across 11 CEMS during the period 1995 to

2016. Furthermore, to our knowledge, none of the papers were devoted to CEMS countries. This is relevant especially because a significant amount of investment was oriented to infrastructure investment for the programming period 2007–2013. The main novelty of our approach lies in contrasting transport infrastructure effects with other factors, such as population, gross fixed capital formation and trade openness, which may also play an important role in stimulating economic growth. Furthermore, this work seeks to empirically explore the current state of affairs and to create a framework for further research development. To achieve this aim, we use panel data regression analysis.

The remainder of the second part of dissertation is structured as follows. The section 2.2. continues with the theoretical background and literature review. Data description is given in section 2.3., while the methodology is explained in the section 2.4. Section 2.5. discusses the results and policy implications, and the section 2.6. presents concluding remarks.

2.2. THEORETICAL BACKGROUND

Transport infrastructure is widely thought to promote growth, thus the impact of transport infrastructure on economic growth was recognized a long time ago in many of the studies mentioned below. Obviously, the link between transport and economic growth has intrigued researchers for decades. According to Rostow (1960), the introduction of railways was a factor in growth and development in the United States, France, Germany, Canada and Russia. In the 1970s, Arrow and Kurz (1970) included the theoretical analysis of the effects of transport infrastructure in growth theories. Krugman (1991a) argues that transport accessibility affects global development paths and can boost economic growth, but also create a barrier to it.

Many researchers have analysed the impact of infrastructure on regional competitiveness, economic growth, income inequality, labour productivity, environmental impact and well-being (Baldwin and Dixon, 2008). Mamatzakis (2008) argues that infrastructure is one of the most important components of economic activity in Greece. His predictions show that public infrastructure reduces costs in most manufacturing industries, boosting resource productivity growth. Aschauer's research (1989) suggests that reducing public investment in transport infrastructure causes a significant decrease in productivity growth. He argues that the reduction in U.S. public utility productivity may be crucial in explaining the overall decline in productivity growth rates in the country. Efficient infrastructure supports economic growth, improves quality of life and is important for national security (Baldwin and Dixon, 2008).

Authors argue that infrastructure investments can stimulate organizational and management change; for example, construction of the rail system will lead to standardization of the schedule, which, besides the rail service alone, leads to revenue growth (Mattoon 2004). Tsekeris and Tsekeris (2011) discuss that transport investment, especially investment in highway, rail, airport and seaport infrastructure, requires long-term financial commitments. Public infrastructure provides geographic concentration of economic resources and a deeper and wider market for growth of output and employment (Gu and Macdonald, 2009). Transport infrastructure can affect economic growth by changing aggregate demand; for example, building transport infrastructure can create and increase demand for intermediate products from other sectors and stimulate multiplier effects in the economy (Pradhan and Bagchi, 2013).

Public infrastructure is generally seen as the foundation on which the economy is built (Macdonald 2008). Aschauer (1989) argues that public infrastructure is the foundation of quality of life: good roads reduce accidents and increase public safety, the water supply system reduces disease levels, and waste management improves health and the aesthetics of the environment. Agénor and Moreno-Dodson (2006) investigated the link between the presence of infrastructure, health and education in the community, and their results show that infrastructure services are essential to ensuring the quality and accessibility of health and education, which largely enables wealth performance. Demetriades and Mamuneas (2000) argue that infrastructure has a significant positive impact on income, demand for private production and product delivery in 12 OECD countries. Montolio and Solé-Ollé (2009) confirmed that public investments in road infrastructure have positively impacted the relative increase in labour productivity in the Spanish regions. Snieska and Bruneckiene (2009) identify infrastructure as one of the regional competitiveness indicators of a country. This refers to physical infrastructure (road infrastructure, telecommunications, new-built real estate, land access, land and air) as indicator of production factors and competitive conditions in the region.

Martinkus and Lukasevicius (2008) argue that infrastructure services and physical infrastructure are factors that can influence the investment climate at the local level and raise the level of attractiveness of the region. Nijkamp (1986) argues that infrastructure is one of the tools of regional development. It can directly or indirectly affect socio-economic activities and other regional capacities, as well as production factors. The author emphasizes that infrastructure policy is a prerequisite for regional development policy: it does not guarantee regional competitiveness but creates the necessary conditions for achieving the goals of regional development. More recently, Badalyan, Herzfeld and Rajcaniova (2014) investigated the relationship and the direction of causality between transport infrastructure, infrastructure investment and economic growth, using a vector error correction model in the case of Armenia, Turkey and Georgia. Their results show that gross capital formation and road/rail goods transported have a positive and statistically significant impact on economic growth in the short run and show the existence of bidirectional causality between economic growth and infrastructure investment, and between road and rail passengers carried and infrastructure investment in both the short and long run.

Ismail and Mahyideen (2015) empirically explore the effects of transport infrastructure on international exchange and economic growth in Asia, and the results have shown positive effects on the rise in international exchange as well as on economic growth. Furthermore, Purwanto (2017) analyse the relationship between transport infrastructure investment and its wider economic impacts, namely competitiveness and economic growth, and recommend methodology improvements. Mohmand, Wang and Saeed (2016) use the unit root, cointegration, and Granger Causality model to estimate the causal linkages between economic growth and transportation infrastructure existing at national and provincial level. Their results suggest that there is no causality between the two variables in the short run, at the national level; however, a unidirectional causality from economic development to infrastructure investment exists in the long run.

In the case of Croatia, an EIZ (2014) study shows that there is a causal link between transport infrastructure, transport services and the level of international exchange. Infrastructure should be viewed as the building blocks of each economy, which provide support to produce goods and services and is not part of the production process. Since macroeconomic growth theories explicitly do not include the concept of infrastructure systems, although infrastructure plays a very important role in economic development, Carlsson, Otto and Hall (2013) have explored the role of infrastructure in macroeconomic growth theories and confirmed that certain economic functions of infrastructure may be represented in existing macroeconomic models, so new economic geography (growth) enables the presentation of transport infrastructure due to a more spatial approach. However, some studies (for example Devarajan, Swaroop and Zhou 1996; Canning and Pedroni 2008; Nketiah-Amponsah 2009; Yu et al., 2012; Crescenzi and Rodríguez-Pose 2012) argue that transport infrastructure alone is not sufficient for reaching higher gross domestic product (GDP) and that infrastructure endowment is a relatively poor predictor of economic growth. It seems that the vast body of evidence is far from being conclusive, and that the role of transport infrastructure depends on different circumstances. Therefore, it is important to be aware of other drivers of economic growth because they have important implications on the transport infrastructure's impact on economic growth.

2.3. DATA AND DESCRIPTIVE STATISTICS

In this research, panel data analysis has been used for eleven Central and Eastern EU Member States (CEMS) in the period 1995–2016. The CEMS countries analysed in the paper are, from north to south: Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Romania and Bulgaria. The original sample included Malta and Cyprus; however, those countries were excluded from the estimation since they have no railway network established. We selected CEMS countries for our analysis for the following reasons: first, all of them experienced the transition towards market economies; second, they have been receiving significant EU funding to be invested in transport infrastructure since they are new EU Member States; and third, there is a gap in the literature regarding the effects of transport infrastructure in CEMS countries.

The economic model employed in this paper includes six variables: Economic Growth (EG), Population (POP), Infrastructure Investment (GFCF), Trade Openness (OPEN), Railway Transport Infrastructure (RAIL) and Road Transport Infrastructure (ROAD), and has the following format:

$$EG = f\,(POP, GFCF, OPEN, RAIL, ROAD) \qquad [2.1]$$[1].

In our analysis we use GDP as a proxy variable for level of a country's output. As control variables which usually have an impact on economic growth (Barro and Lee 2013, Ismail and Mahyideen 2015, Keho 2017), we use the following three variables: variable population (number of inhabitants), variable gross fixed capital formation as a proxy for infrastructure investment, and a third variable, trade openness. For transport infrastructure we follow Pradhan and Bagchi (2013); as a proxy variable for railway infrastructure, we use length of total railways, while as a proxy variable for road transport infrastructure we use length of total road network, where both variables are expressed in kilometres. All data are obtained from the Eurostat Database (2017).

Table 2.1 contains descriptive statistics of all used variables in the model 1. Descriptive statistics consist of seven columns where the most important is the fourth column, which shows the standard deviation of each variable between and within the observed countries. According to the data presented in Table 2.1, it can be seen that the standard deviation, for example the variation between observed countries is higher than the variation within countries, which is reasonable because our sample is heterogeneous. It is quite interesting that in the case of the variable rail, the variation between observed countries is more than 10 times higher than within countries, whereas in the case of the variable road the variation between and within countries is much smaller, indicating that the road infrastructure within the observed countries is much more similar than the rail infrastructure. Certainly, the descriptive statistics itself is not enough to be able to draw conclusions with certainty. The original sample consisted of 13 countries, the 11 mentioned in the data description and Malta and Cyprus. However, Malta and Cyprus were excluded from the estimation as they have no railway network established.

[1] In model 1 we did not control for the other factors that affect economic growth, such as technology, financial development, labour market, institutions, monetary factors etc. Not controlling for these variables could lead to a potential bias in our estimates. Therefore, we perform additional estimations that consider the above factors. The results of the additional estimates are reported in Appendix A.

Table 2.1. Descriptive statistics (Model 1)

Variable	Units	Category	Mean	Std. Dev.	Minimum	Maximum
gdp	mil. EUR	overall	58825.47	78879.96	2829	430037.8
gdp		between		72555.98	5648.214	272993.9
gdp		within		36682.12	-105452.7	215869.4
pop	absolute values	overall	8268950	1.03e+07	376433	3.87e+07
pop		between		1.07e+07	403086	3.82e+07
pop		within		337493.6	6762588	9714668
gfcf	mil. EUR	overall	13575.99	17046.76	435.3	86396.1
gfcf		between		15526.54	1174.914	55572.1
gfcf		within		8202.54	-23041.01	44669.77
open	ratio	overall	1.218494	.5117014	.4367842	3.264139
open		between		.478885	.7190229	2.584769
open		within		.2222736	.6307528	1.897865
rail	kilometres	overall	6028.499	5797.434	925	23986
rail		between		6031.518	1079.92	21013.05
rail		within		473.5529	4246.451	9001.451
road	kilometres	overall	451.4231	378.7293	0	1883.9
road		between		290.9813	0	935.745
road		within		254.6779	-149.3219	1399.578

Source: Authors' calculation

As a robustness check of the original model [2.1], we employ additional model [2.2]. The additional model is based on Aschauer's (1989) aggregate production function, that we modified considering our research area. Variables Output-side real GDP at chained PPPs, Number of persons engaged (in millions), Average annual hours worked by persons engaged and Capital stock at current PPPs (in mil. 2017US$) are obtained from Penn World Tables (2021), version 10, while transport infrastructure data come from Eurostat Database (2017). In the absence of a standard or "best practise" procedure for the selection of transport infrastructure variables (Crescenzi and Rodríguez-Pose 2012), Model 1 uses the length of highways and railways as proxy transport infrastructure variables. However, this measure may introduce potential biases in the estimates for two reasons: First, we restrict our analysis only to rail and road transport infrastructure, ignoring other types of infrastructure such as seaports and airports, which could also have significant effects on economic growth; and second, our "length" variables do not account for differences in country size. Therefore, in addition to rail and road infrastructure as regressors, we also include seaport and airport infrastructure in aggregate production function. The proxy variables for transport infrastructure are expressed in million tonnes per kilometre – tkm and thousand tonnes (in case of seaport infrastructure) which better reflect the efficiency of transport infrastructure.

Our additional economic model has the following structure:

$$Y = f\,(A, K, T) \qquad [2.2],$$

where Y stands for output per worker, A presents total factor productivity, K is capital per worker and T presents transport infrastructure. The aggregate production function (AGP) model includes eight CEMS countries (Bulgaria, Croatia, Estonia, Latvia, Lithuania, Poland, Romania, and Slovenia) for which we have data for all types of infrastructure. Table 2.2 shows descriptive statistics of all used variables in additional economic model [2.2].

Table 2.2. Descriptive statistics of all AGP variables for CEMS countries (Model 2)

Variable	N	Mean	Std. Dev.	Minimum	Median	Maximum
output_pw	286	48765.03	14817.198	16779.37	49745.79	80934.11
avh	286	1873.29	137.955	1640.254	1861.762	2277.383
capital_pw	286	222640.55	1.25e+05	26474.93	187880.9	638893.4
rail_infrastructure	149	13575.87	13022.626	2086	10158	54253
road_infrastructure	165	34959.86	51612.735	538	18674	290745
seaport_infrastructure	159	31183.65	19363.608	3101	27513	72926
airport_infrastructure	117	343.85	340.508	1	244	1412

Note: output_perworker and capital_perworker are expressed (in mil. 2017US$)

Source: Authors' calculation

2.4. METHODOLOGY

The aim of this research is to investigate the effects of infrastructure on economic growth. Our analysis is based on the panel data regression. The panel data can be used to control for unobserved factors which affect the dependent variable that can be either time fixed or time varying (Wooldridge 2016). To empirically test the effects of transport infrastructure, the following econometric model has been estimated, based on economic model from equation [2.1]:

$$gdp\_output_{it} = \beta_0 + \beta_1 pop_{it} + \beta_2 gfcf_{it} + \beta_3 open +_{it} \beta_4 rail_{it} + \beta_5 road_{it} + \lambda_t + u_{it} \quad [2.3],$$

where depended variable is GDP output level, while population (*pop*), gross fixed capital formation (*gfcf*), trade openness (*open*) and road and railway (*rail* and *road*) are used as regressors. Variable λ_t denotes the time fixed effects and u_{it} is the usual stochastic disturbance term (Baltagi 2005). The *i* denotes the cross-sectional unit (country) and *t* the time period (year).

As a robustness check of econometric model [2.3], we follow the approach of Aschauer (1989), in which is estimated the aggregate production function. We modify his original model by adding a measure of rail and road infrastructure, resulting in the following econometric model:

$$output\_pw_{it} = \beta_0 + \beta_1 avh_{it} + \beta_2 capital\_pw_{it} + \beta_3 rail\_infrastructure_{it} + \beta_4 road\_infrastructure_{it} + \beta_5 seaport\_infrastructure_{it} + \beta_6 airport\_infrastructure_{it} + \lambda_t + u_{it} \quad [2.4],$$

whereas $output\_pw_{it}$ presents output per worker measured as the ratio of output-side real GDP at chained PPPs and number of persons engaged in country. As a regressors we use avh_{it} - average annual hours worked by persons engaged, $capitappw_{it}$ stands for capital per worker proxied by ratio of capital stock at current PPPs and number of persons engaged. $rail\_infrastructure_{it}$, $road\_infrastructure_{it}$ and $airport\_infrastructure_{it}$ is measured as the freight transport expressed in tonnes per kilometres. $seaport\_infrastructure_{it}$ is measured as freight transport expressed in thousand tonnes. We log transform all variables of the Model 2.4. Variable λ_t denotes the time fixed effects and u_{it} is the stochastic disturbance term.

The standard approach in panel data analysis (linear model) includes three different estimators: POLS, FE and RE, each of them being suitable for estimating a model if certain assumptions are met. In practice, for macroeconometric modelling, FE is usually used. Although it is a priori assumed that the FE model is the most suitable for both estimations, this paper presents the results of estimating the economic models with all three of the above estimators. POLS, which applies only if the countries are homogeneous. For example, economic and political structure which might affect the dependent variable but is difficult to be measured explicitly and is contained in the error term, is similar across countries. The FE estimator is used when estimating the effects that vary over time, considering that individual panel unit specificities are correlated with one or more regressors. Namely, each unit (country) has its own specifics that do not change over time (i.e., geographic position, culture, language, etc.) and it is expected that these characteristics will be correlated with regressors, i.e., independent variables. The FE estimator removes specificities by time demeaning, resulting in estimates of the time varying variables only. On the other hand, if we assume that individual specificities are independent of regressors, the RE estimator is appropriate. Technically, we use the Hausman test to decide which estimator is more suited to the data in hand and, as is usually the case in empirical research, the Hausman test rejects H_0, that is, that RE is consistent and efficient as well as FE and therefore we should stick with FE.

These estimators were selected based on previous empirical research that used fixed and random effects to assess the effects of transport infrastructure on international trade (Ismail and Mahyideen 2015) and the effect of vertical separation on the success of railway system (Laabsch and Sanner 2012). Since we are working with a relatively small sample, we report the results of all three estimators to see whether the results are consistent.

2.5. RESULTS AND DISCUSSION

The estimated results of POLS, FE and RE are reported in Table 2.3 The first column shows the results of the test with the POLS. estimator, the second column presents the results of the estimator FE and the third column shows the results of the estimator RE.

According to the obtained results, in the case of the estimators POLS and RE, all the variables are significant, while in the case of FE only the variable trade openness is not significant. The results of the regression highlight significant and positive effects on economic growth of all observed variables except the variable railway.

Table 2.3. Results of the Model 1

Variables	POLS gdp	FE gdp	RE gdp
pop	0.00403***	0.00914**	0.00880***
	(0.000391)	(0.00340)	(0.000889)
gfcf	3.991***	3.521***	3.577***
	(0.212)	(0.317)	(0.232)
open	16,228***	10,458	11,817*
	(4,255)	(7,655)	(6,865)
rail	-5.454***	-14.77***	-13.49***
	(0.936)	(1.746)	(1.433)
road	14.54***	13.63*	14.16*
	(3.285)	(7.273)	(7.249)
Constant	-18,555***	-2,880	-9,357
	(6,400)	(41,195)	(7,296)
Time Fixed Effects	Yes	Yes	Yes
Observations	217	217	217
R-squared	0.979	0.972	0.953
Number of Country	11	11	11

Robust standard errors in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Authors' calculation

According to the obtained results, in the case of the estimators POLS and RE, all the variables are significant, while in the case of FE only variable trade openness is not significant. The results of the regression highlight significant and positive effects on economic growth of all observed variables except the variable railway. Population growth, gross fixed capital formation and trade openness have positive effects on economic growth, while in the case of railway infrastructure, all three estimators show significant ($p<0.01$) and negative effects of railway infrastructure on economic growth in the observed period for eleven CEMS countries.

As has been indicated, the assessment of the impact of transport infrastructure on economic growth should take into consideration other important growth drivers. Results of the model 1 confirm the link between economic growth and a combination of population size, investments, road infrastructure endowment and trade openness. Road infrastructure in the CEMS is relatively modern and highly developed, and our findings show that the total road network has a positive and significant coefficient at least at the 5% significance level, depending on estimator. Some other studies (for example Ismail and Mahyideen 2015) have also concluded that long road networks lead to easier access to the workplace, thus boosting productivity and consequently economic growth. Developed road infrastructure allows other economic activities such as trade and tourism, which have important effects on economic growth in all CEMS in a way, these results are even underestimated because, according to Crescenzi and Rodriguez-Pose (2012), the road infrastructure variable does not capture its wider impact on economic performance. The reason is that the Keynesian multiplying effects during the construction phase have not been included in the data. The road infrastructure network data are based solely on the quantity (kilometres) of infrastructure actually built and currently in use and are not complemented by any expenditure data. Since official statistics only record new infrastructure after final completion, our proxy captures mainly the ex-post impact of transport infrastructure on economic activity. Railway infrastructure does not have positive effect on economic growth (in case of Model 1).

Railway infrastructure in CEMS is outdated and inefficient, and according to the European Parliament transport analysis in 2016, there are gaps and bottlenecks in connectivity and travel time in CEMS railway systems. Data show that travel times in the old member states (EU15) are two to four times faster than in the CEMS Furthermore, the North–South connection through the three Baltic States constitutes a railway gap. Ports and their railway connections to the hinterland are dealing with the limitations at both ends of the Baltic–Adriatic corridor, while several railway cross-border bottlenecks are recorded between most of CEMS countries and between CEMS and EU15 countries. It is not surprising that the results of our analysis report a negative and significant coefficient ($p<0.01$) in the case of all three estimators.

The estimation of the production function has always been plagued with endogeneity problem. Seminal papers that try to estimate production function while explicitly adressing endogenity are those of Wooldridge (2009) and Ackerberg et al (2015). Both papers address same issue but with different approaches; while Ackeerberg et al. (2015) use two-stages approach, Wooldridge is advocate of one equation approach within Generalized Methods of Moments (GMM) estimation framework. GMM uses lags and differentiations of dependent variables and independent variables as instruments and in that way, achieves unbiased and consistent estimates of the parameters. Therefore, we also estimate aggregate production function using GMM estimator. Table 2.4. shows results with POLS, FE and RE estimators that were used in our original model, while table 2.5.

shows results of the robustness check, of aggregate production function estimation using GMM estimator.

Table 2.4. Results of the Model 2

Variables	logPOLS lnoutput_pw	logFE lnoutput_pw	logRE lnoutput_pw
lnavh	1.219***	-0.507	-0.327
	(0.213)	(0.275)	(0.297)
lncapital_pw	0.214***	-0.0584	0.0564
	(0.0412)	(0.129)	(0.118)
lnrail_infrastructure	-0.0401	-0.0118	-0.0341
	(0.0387)	(0.0432)	(0.0474)
lnroad_infrastructure	0.144***	0.0360	0.0387
	(0.0248)	(0.0288)	(0.0460)
lnseaport_infrastructure	-0.0184	0.0887	0.0892
	(0.0734)	(0.0495)	(0.0557)
lnairport_infrastructure	-0.119***	0.0920	0.0467
Time Fixed Effects	Yes	Yes	Yes
Constant	-1.234	13.61***	11.29***
	(1.279)	(2.821)	(2.385)
Observations	72	72	72
R-squared	0.817	0.862	
Number of Country		8	8

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculation

For the APF estimation (Model 2), we include other types of infrastructure, namely seaport and airport infrastructure, as regressors. Moreover, in Model 2, instead of using the simple length of infrastructure, we use transport of freight in million tonnes per kilometre (tkm) as a proxy for rail, road, and airport infrastructure, and transport of freight in thousand tonnes as a proxy for seaport infrastructure. The estimation results show that all transport infrastructure except road infrastructure is not significant for economic pefromance. Only road infrastructure shows significantly positive results in the case of the POLS estimator. Air infrastructure also shows negative and significant effects on economic performance with the POLS estimator.

Table 2.5. Results of the Model 2 with GMM estimator

VARIABLES	(1) lnoutput_pw	(2) lnoutput_pw
L.lnoutput_pw	0	0.868*
	(0)	(0.444)
lnavh	0	-2.104
	(0)	(2.668)
lncapital_pw	0.776***	-0.505
	(0.0845)	(0.397)
lnrail_infrastructure	0	-0.166*
	(0)	(0.0996)
lnroad_infrastructure	0.232***	0.222**
	(0.0369)	(0.109)
lnseaports_infrastructure	-0.101	0.255
	(0.0858)	(0.342)
lnairport_infrastructure	0	0.263
	(0)	(0.201)
Time Fixed Effects	YES	NO
Constant	0	18.66
	(0)	(19.67)
Observations	72	72
Number of Country	8	8
Number of instruments	22	22
AR(1) p-value	0.680	0.580
AR(2) p-value	0.833	0.640
Sargan test p-value	0.941	0.002
Hansen test p-value	1.000	1.000

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculation

The aggregate production function with GMM estimator again show significant and positive effects of road infrastructure on output, and negative and significant effects of rail infrastructure on output, in case when time (yearly) fixed effects are not included. Seaport and airport infrastructure are not significant. However, we must point out that our estimation is performed on dataset with only 72 observations (eight countries). The problem with the results of the basic GMM model is that the Arellano-Bond test for AR(1) and the Arellano-Bond test for AR(2) are not valid (by definition, null hypothesis of no serial correlation should be rejected for first lag, but not for the second.). The results of the Hansen test are suspiciously "good" (p value equal to 1), while the H_0 of Sargan test is not rejected only for model with time (yearly) fixed effects.

The results of the additional estimates in Appendix A, where we include other factors affecting economic growth, show that only road and seaport infrastructure (in some cases) are significant and positive for economic growth. These results confirm that we cannot draw precise conclusions regarding transport infrastructure and its role in economic growth.

2.6. CONCLUSION

The role of transport and transport infrastructure in the economic growth and competitiveness of a country has been recognised in many studies, but it is still an ongoing topic in scientific circles as some research results have been inconclusive. Generally, it is considered that in the era of globalisation, economic progress of the economy, among other things, depends on the efficiency of passenger and goods transport, while the lack of inadequate transport infrastructure remains an important obstacle. Having in mind this wider context, the motivation of this paper is to empirically investigate the effects of transport infrastructure on economic growth in the CEMS, taking into account the set of variables that shape the relationship between transport infrastructure and economic dynamics. This study has examined the effects of transport infrastructure on economic growth in CEMS using data for the 1995–2016 period. This study has concluded that road infrastructure, gross fixed capital formation, population and trade openness have positive effects on GDP output level, while rail infrastructure has negative effects on GDP output level. The additional model used to check robustness, the aggregate production function model, also includes seaport and airport infrastructure. The results of the aggregate production function show that only road infrastructure has positive and significant effects on the output. The results of our estimation clearly indicate that other types of infrastructure have insignificant impact on output. The results of the additional tests that we report in Appendix A, again show that only road infrastructure have a positive and significant impact on economic growth, but even these results are on “thin ice”.

We acknowledge that our research is limited by the lack of data (short time period under consideration) and thus are not robust. Further analysis could focus on a larger sample size and also incorporate dynamic analysis and instruments to avoid potential bias in the results that we could not account for with this dataset. Due to the lack of available data and the small number of observations, we cannot draw a firm conclusion regarding the relationship between transport infrastructure and economic growth. From the economic policy point of view, in order to simulate sustainable economic growth in CEMS countries, other accompanying factors such as the economic environment, investments, institutions, ICT technology and logistics services, which work hand in hand with the infrastructure itself, should be considered in addition to the transport infrastructure. The study provides insight into the impact of different types of transportation infrastructure on economic growth in CEMS countries. The policy makers should rethink their CEMS development policies and strategies in such a way that investment in infrastructure and the development of Trans European Transport Networks are considered in a broader context that includes other related activities such as logistics and trade facilitation that simultaneously shape and depend on transport infrastructure.

3. THE EFFECTS OF LOGISTICS PERFORMANCE ON INTERNATIONAL TRADE: EU15 VS CEMS

Abstract

Even though trade tariffs have generally fallen since the GATT agreement, non-tariff trade barriers still exist and show an upward trend. An important type of non-tariff trade barrier is logistics service related to the transport of goods to foreign markets. Efficient logistics is of great importance for small and open economies such as the Central and Eastern EU member countries that became EU members in 2004 or later and are in the process of economic convergence with the old EU member countries, mostly through trade. On the other hand, logistics is important for old EU member countries because it influences competitiveness in global supply chains. The aim of this paper is to examine the homogeneity of the two blocks of EU countries in terms of logistics performance, i.e. to examine the impact of logistics performance on the international bilateral trade of the EU15 and CEMS with the rest of the world in the period 2010–2018. We develop and estimate a structural gravity model with Poisson pseudo-maximum probability estimator, using the LPI and its sub-indices as the main independent variables of interest. Our results show that differences in LPI values have heterogeneous impact on bilateral trade, especially when considering trade in different classes of goods and different groups of country pairs.

Keywords: bilateral trade, gravity model, logistics performance index, EU15, CEMS

JEL classifications: F13, F14, F23

3.1. INTRODUCTION

Logistics is strongly connected to trade and its contribution to the trade competitiveness of countries is growing, especially since the trade tariffs have largely declined due to the trade liberalization process than began after General Agreement on Tariffs and Trade came into force in 1948. Efficient transport and logistics can boost trade, however inefficient transport and logistics can become a barrier to it, therefore we consider it as a non-tariff barrier. Nords and Piermartini (2004) argue that the cost of transporting goods to foreign markets presents a good example of non-tariff barriers. However, it is not just the transport costs that matter; security, quality of infrastructure, customs procedures, and the length of time that it takes for goods to be shipped matter as well. Hummels (2001) states that the time that it takes for goods to be shipped and the unpredictability related to time are also costly to traders. 'International trade calls for flows to be organised and synchronised through strategic nodes and networks that facilitate storage, conservation and any other value-added service required due to the very characteristics of the goods being transported' (Puertas, Marti and Garcia 2014, p. 468). The World Bank has developed the logistics performance index (hereinafter: LPI) as a benchmarking tool to help countries identify the challenges and opportunities, they face with respect to logistics performance. LPI is used to analyse differences between countries in terms of logistics costs and the quality of the infrastructure for overland and maritime transport (Marti, Puertas and Garcia 2014b). Numerous papers in this field have found the positive links between trade facilitation and/or logistics performance and trade, (Wilson, Mann and Otsuki 2003; Behar and Manners 2008; Marti, Puertas and Garcia 2014a; Marti, Puertas and Garcia 2014b). However, their investigations only considered the links between absolute value of logistics performance index (or its sub-indices) and total/aggregate trade (or specific product groups), but there were no investigations how particular LPI sub-index affect particular product groups.

This paper investigates the impact of the difference of logistics performance sub-indices (hereinafter LPI) values between trading partners on their bilateral trade covering the biennial period from 2010 to 2018. We investigate if the difference in LPI matters and does it affect bilateral trade. Our paper extends the existing literature in a way that we classify trading goods using Broad Economic Categories (BEC) classification, that we then aggregate to the three basic System of National Accounts (SNA) classes of goods: intermediate, capital and consumption goods. In that way we also investigate for potential heterogeneous impact of LPI differences with respect to different classes of goods. There is a scarce literature on the product or product groups-specific research in this research field, and there is lack of empirical findings about the effects of improvements in trade logistics on trade in specific product groups. Our assumption is that different logistics functions do not matter equally to different products, for example the perishable nature of food products or the sensitivity of chemical products makes them more vulnerable to delays in trade (Liu and Yue, 2013). Therefore, this paper attempts to detect possible differences in trade of different classes of goods. In order to estimate the effects of logistics performance on international trade we use structural gravity model. As a proxy variable for logistics performance, we use LPI, that is, its six sub-indices, namely 'the efficiency of customs and border management clearance, the quality of trade and transport infrastructure, the ease of arranging competitively priced shipments, the competence and quality of logistics services, the ability to track and trace consignments, and finally, the frequency with which shipments reach consignees within scheduled or expected delivery times' (Arvis et al. 2018).

Our paper also addresses the gap in the literature investigating how trade patterns vary across different groups of countries. Our focus are European Union member countries, where we distinguish between old EU member countries (hereinafter EU15) and new EU member countries or so-called Central and Eastern EU member countries (hereinafter CEMS). We compare effects of the difference in LPI on bilateral trade between these two groups of countries and Rest of the World (ROW) countries. There is a clear lack of research of the differences in logistics performance within economic integrations and its impact on trade flows. We emphasise the importance of this research for CEMS countries, well known for relatively complicated transition from planned to market economy, outdated transport infrastructure, but also good geographical position and membership in the EU. According to the Mordor Intelligence (2018) Report, CEMS, such as Czech Republic, Hungary, Poland, and Slovakia, are among the fastest growing economies in the EU. However, their logistics market is still in infant phase, and undeveloped in comparison with the logistics markets of old EU member countries. CEMS need to address poor infrastructure, especially railways, political corruption, lack of competitiveness etc. Despite the current issues, the CEMS are an attractive location for the investments in logistics. Therefore, from the macroeconomic point of view, it is important to take into consideration the potentials of CEMS logistics market and its impact on international trade. On the other hand, we have EU15, EU core group of countries that we basically use as a benchmark for CEMS.

This paper contributes to the existing literature in several ways, covering the connection between logistics performance and international trade in different classes of goods. It evaluates the importance of the logistics services in international trade studies, and it analyses how differences in LPI sub-indices levels between trading countries impact bilateral trade flows, differentiating between two groups of countries within economic integration, namely EU. As such, our research follows recent work on the effects of trade costs, where logistics performance plays a significant role (Saslavsky and Shepherd, 2014). The remainder of the paper is structured as follows: Section 3.2 reviews the literature related to trade logistics research. Section 3.3 presents the methodology used in the empirical part of the paper. Section 3.4 explains the data and variables included in the analysis. Section 3.5 discusses the results and policy implications, and finally, Section 3.6 presents concluding remarks.

3.2. LITERATURE REVIEW

Trade liberalization and the tariff reductions motivated researchers to start investigating the effects of non-tariff barriers on international trade, respectively the effects of reductions of transport costs and other barriers to trade, so called 'trade facilitation', on international trade (Anderson and van Wincoop 2004; Baier and Bergstrand 2001; Brun et al. 2005; Clark, Dollar and Micco 2004; Hummels 2001, 2007; Limao and Venables 2001). As many authors note, improvements in trade facilitation leads to international trade growth. In their seminal paper, Wilson et al. (2003) estimates the effects of trade facilitation on trade in APEC countries. To measure the effects of trade facilitation, they employed the gravity model where port infrastructure, customs environment, regulatory environment, and e-business infrastructure were used as proxy variables for trade facilitation measures. In 2005, same authors expand their research; they estimate the effects of trade facilitation on trade in manufactured products for 75 countries in the period from 2000 to 2001. The results of both studies suggest that improvements in all four trade facilitation measures lead to increase in international trade. Soloaga, Wilson and Mejia (2006) study the effects of changes in trade facilitation on trade in Mexican main industrial sectors and their results suggest that trade facilitation measures should be taken seriously when creating trade policies since the improvement in trade facilitation could increase export by approximately 20% and imports by 11%.

Iwanow and Kirkpatrick (2007) investigate the impact of regulatory quality and trade facilitation on export. The results of their gravity model suggest that all trade facilitation measures, including improved transport and communications infrastructure increase exports. Portugal-Perez and Wilson (2010) use physical infrastructure, information and communications technology, border and transport efficiency, and business and regulatory environment as trade facilitation proxy variables in order to detect their effects on trade volume and the results also support aforementioned findings. According to Djankov, Freund and Pham (2010), each additional day that a product is not being dispatched, reduces trade by more than 1% and that percentage is even higher in case of perishable products, such as agricultural products, meaning that perishable products are more time sensitive.

For the first time, in 2007, the World Bank published the Logistics Performance Index which includes all above mentioned trade facilitation measures i.e., customs clearance, transport infrastructure, quality of logistics service, timeliness and the ability to track the shipment. LPI received significant attention in the international trade literature and public policy discourse and researchers started to use it as a proxy variable for trade facilitation and include it in the international trade analysis. Behar and Manners (2008) incorporate LPI 2007 for the first time in their gravity framework in order to investigate the effects of the logistics of source and destination country on bilateral exports and the effects of logistics of countries' neighbours on exports. They use aggregate LPI as a proxy variable for logistics of source and destination country and their findings show that logistics positively affect exports, however bordering countries' logistics matters only for the landlocked exporters. Moreover, the results also show that the destination country's neighbours' logistics is negatively related to exports to that country. They explain those findings as a matter of choice. Namely, exporting countries choose between numerous disembark places and mostly send their goods to the 'relatively well-equipped countries before allowing regional distributors to take over'.

Hertel and Mirza (2009) and Felipe and Kumar (2012) contribute to the literature by including LPI index and its sub-indices as trade facilitation measures in order to estimate the effects of trade facilitation on trade in Asian countries by using gravity model approach. While Hertel and Mirza use only one LPI sub-index in each regression, Felipe and Kumar incorporate all the LPI sub-indices in one equation. Both analyses conclude that trade facilitation positively affect trade and that infrastructure is the most important LPI sub-index. According to Felipe and Kumar' estimation, the gains in trade vary from 28% in case of Azerbaijan to 63% in case of Tajikistan. Their results also suggest that from the exporter point of view, infrastructure has the greatest impact on trade while from the importer side, customs efficiency has the greatest impact on trade.

Puertas, Marti and Garcia (2014) and Marti, Puertas and Garcia (2014a, 2014b) also estimate the effects of logistics performance on international trade. All three-studies base research on gravity model and use LPI as proxy variable for logistics performance and as in Behar and Manners (2008) their results show significant positive effects of logistics performance of trade, implying that logistics is more important to the exporting than to the importing countries. Furthermore, authors recommend the enhancement of exporter-oriented policies and interventions. Puertas, Marti and Garcia (2014) focus research on 26 EU countries in the period from 2005 to 2010. In the case of EU countries, the competence and quality of logistics services record the highest score, followed by the ability to track and trace consignments and the quality of customs and infrastructure. This results actually show better performance of the EU private sector in case of trade facilitation since components with the highest impact are in reliability of the private sector.

Marti, Puertas and Garcia (2014a, 2014b) estimate the effects of logistics performance on trade flows in emerging countries grouped in five regions, Africa, Eastern Europe, Far East, South America and Middle East. They control for the trade between different groups of products in accordance with their logistics complexity and their findings show that the more difficult is to transport goods, the more important becomes logistics performance. Similarly, Saslavsky and Shepherd (2014) investigate the effects of logistics performance on trade in parts and components within international production networks and their main conclusion is that trade in parts and components is more sensitive to logistics performance than trade in final goods. Bresslein and Huber (2016) analyse trade patterns of EU countries distinguishing between trade in parts, components and final goods using Eurostat COMEXT database at 8-digit level. Their findings confirm that trade patterns differ for different types of products, namely parts, components, and final goods and that all EU countries are active through all supply chain, however while developed countries trade mostly with other developed countries, less developed EU countries trade with more developed countries.

Latest findings of Gani (2017) and Host, Pavlić Skender and Zaninović (2019) estimate the effects of logistics performance on international trade using cross-country data for a large sample of countries and both agree that logistics performance have statistically significant and positive effect on trade flows, particularly on exports. In addition, Bugarčić, Skvarciany and Stanišić (2020) analyse the impact of logistics performance on trade volume within two groups of countries, Central and Eastern EU and Western Balkan countries, and conclude that sub-indices international shipments, logistic quality and competence and tracking and tracing have the highest effects on trade volume in observed year 2018. Finally, the majority of empirical studies agree that logistics performance and trade facilitation, in general, play an important role in international trade. The findings reveal that logistics and transport is increasingly important for trade across supply chains and therefore is necessary to investigate and better understand how trade patterns vary across different groups of countries within economic integration and how logistics performance and its sub-indices affects trade in different groups of products. Participation in regional and global supply chains, especially for new EU countries is significant for their competitiveness and therefore our aim is to detect the effects of logistics performance on EU trade in specific group of products across and offer suggestions for further trade and logistics policies.

3.3. METHODOLOGY

In our research, the theoretical framework to investigate the effects of logistics service performance on international trade is based on the gravity model theory of international trade. Since the pioneer work of Tinbergen (1962), the gravity equations have been frequently used in many trade-related research papers during decades (Anderson and van Wincoop 2004; Behar and Manners 2008; Bergstrand 1985, 1989; Frede and Yetkiner 2017; Host Pavlić Skender and Zaninović 2019; Krugman 1991b; Zajc Kejžar, Kostevc and Zaninović 2016). We develop the following structural gravity model to estimate the effects of logistics performance differences between trading partners on bilateral trade:

$$trade_{ijt} = \beta_0 + \beta_1 gdp_{ijt} + \beta_2 dist_{ij} + \beta_3 lpisub_{ijt} + \beta_4 contig_{ij} + \beta_5 comlang_{ij} + \sum_{i=1}^{k} \delta_i + \sum_{j=1}^{k} \gamma_j + u_{ijt} \quad [3.1],$$

where $trade_{ijt}$ is the value of bilateral trade (imports + exports) in U.S. dollars between reporting country *i* and partner country *j* in year *t* (since LPI data is published biennially, *t* represents years 2010, 2012, 2014, 2016 and 2018). For reporting countries, we have EU28 member countries (so *i* goes from 1 to 28), while *j* includes EU28 member countries as well as ROW *j* goes from 1 to 157; for years 2010 and 2012 our sample has 152 partner countries). This difference of five countries is due to the fact that in 2014 five new countries began publishing LPI scores). gdp_{ijt} presents absolute difference of the GDP (in current US dollars) between country *i* and country *j* in year *t*. $dist_{ij}$ represents distance between capital cities of trading partners. $contig_{ij}$ is a dummy variable with the value one if trading partners share land border, zero if not and $comlang_{ij}$ is dummy variable with the value one if countries have common official primary language, zero if not.

The gravity model is usually estimated with variables in levels, i.e., the absolute size of the GDP of the reporting country and the partner country, since the intuition behind the gravity theory is that bilateral trade between trading partners is proportional to their absolute economic size and inversely proportional to the distance between them. However, in this study, we use as regressors the differences in GDP between trading partners and the differences in LPI sub-indices between trading partners. Following the empirical methodology used to test Linder's theory, we examine whether and to what extent differences in logistics performance between trading partners affect their trade. We note that our approach, using differences of trading partners' variables as regressors is not new it this type of research. Gravity models employed to test Linder's theory/hypothesis use absolute difference between GDPs per capita of the importing and the exporting country as one of the regressors (Arnon and Weinblatt 1998; Atabay 2015, Jošić and Metelko 2018). Furthermore, this approach is used also in other research fields, like fiscal policy, which include bilateral trade data in their analysis (see Holzner et al. 2018). To check the robustness of the model [3.1.], we also estimate the augumented gravity model where the regressors are in levels, namely the absolute size of GDP and the LPI sub-indices (the results are reported in Appendix B).

Terms $\sum_{i=1}^{k} \delta_i$ and $\sum_{j=1}^{k} \gamma_j$ represent exporters and importers fixed effects, respectively. Use of exporter and importer fixed effects has become standard since Anderson and van Wincoop (2004) and Baldwin and Taglioni (2006), because it solves potential biases in estimation results due to different price levels between countries and other country-fixed, country-pair fixed and time-fixed characteristics, depending on the type of data (cross-sectional or panel data).

The problem of endogeneity arises frequently in gravity models. All the main variables of the gravity model are the source of the endogeneity problem. For example, the higher the GDP of a trading partner, the more trade is done, and conversely, the more countries trade, the higher the GDP. When trading partners have signed a trade agreement, they are also expected to trade more. However, countries that trade frequently, extensively, and with different product ranges (i.e., intensive and extensive margins) tend to sign trade agreements. There are several ways to solve the endogeneity problem. Panel data regressions can include country pair fixed effects, time fixed effects, lagged values of the regressors, or even instrumental variables (Yotov et al. 2016; Baldwin and Taglioni 2007). Since we only have LPI data from a five-year period, we estimate a cross-sectional model. In this way, we are not able to include country-pair fixed effects, time fixed effects, or lagged values of regressors in our gravity model. However, using reporting and partner country fixed effects avoids "gold and silver medal" errors (see Baldwin and Taglioni 2006, 2007).

Another possible endogeneity problem may also arise from omitted variable bias. Our model [3.1] includes some standard gravity regressors since the focus of this analysis is on the impact of logistics performance on trade. However, we are aware that there are many other variables that affect bilateral trade, such as the dummy variable for regional trade agreements (RTAs), the exchange rate, to name a few. The omission of these variables may lead to a possible bias in our estimates. Therefore, we control for the RTA dummy variable as well as the reporter and partner country exchange rates in our robustness check model (Appendix B).

Main variable(s) of interest are presented with $lpisub_{ijt}$ and is calculated as absolute difference in one of the six LPI sub-indices between trading partners.

The six LPI sub-indices are the following:

1. efficiency of clearance process (hereinafter Customs)
2. quality of trade and transport infrastructure (hereinafter Infrastructure)
3. ease of arranging competitively priced shipments (hereinafter International)
4. competence and quality of logistic services (hereinafter Logistics)

5. ability to track and trade consignments (hereinafter Tracking)

6. timeliness of shipments with the expected delivery time (hereinafter Timeliness).

Table 3.1. Summary statistics

Variable	N	Mean	Std. Dev.	Minimum	Maximum
trade	64680	1086	6810	0	271843
agdp	63420	882123	1812276	9	20529790
dist	64680	5588.16	3712.592	59.617	19586.182
contig	64680	0.023	0.151	0	1
comlang	64680	0.055	0.227	0	1

Note: Mean, standard deviation, minimum and maximum values for variables trade and agdp (absolute difference in GDPs of country pairs are expressed in millions of dollars.

Source: Author's own calculation

Table 3.2. Summary statistics of the variable lpisub for the full sample

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Customs	64680	0.853	0.536	0	3.01
Infrastructure	64680	0.967	0.615	0	3.2
International	64680	0.681	0.461	0	2.88
Logistics	64680	0.865	0.553	0	2.89
Tracking	64680	0.873	0.569	0	3.05
Timeliness	64680	0.791	0.525	0	3.2

Note: Mean, standard deviation, minimum and maximum values are expressed in millions of dollars.

Source: Author's own calculation

Table 3.3. Summary statistics for average bilateral trade for three groups of countries

Variable	N	Mean	Std. Dev.	Minimum	Maximum
CEMS-CEMS	2340	631	1858	0	29971
CEMS-EU15	2925	1468	5551	0	129709
CEMS-ROW	24765	89	674	0	48.080
EU15-EU15	3150	10130	22846	0	271843
EU15-CEMS	2925	1915	7528	0.14	152171
EU15-ROW	28575	867	5272	0	220694

Note: Mean, standard deviation, minimum and maximum values are expressed in millions of dollars

Source: Author's own calculation

The LPI is based on worldwide survey carried out across more than five thousand freight forwarders and logistics firms who operate internationally. Each respondent rates their trade logistics experience (in six above mentioned dimensions/sub-indices) with the eight countries they trade the most. Further details of the construction of each sub-index are available in Arvis et al. (2018).

The descriptive statistics of the $lpisub_{ij}$ (summary for biennially data from 2010 to 2018) for the full sample is given in Table 3.2. In Tables 3.4. and 3.5. we present results for two sub-samples, for the cases when reporting countries are EU15 countries and partner countries are ROW countries, and when reporting countries are CEMS countries and partner countries are ROW countries.

We estimate Model (3.1) for each LPI sub-index. We couldn't estimate the model with all six LPI sub-indices together due to a high degree of correlation between sub-indices, resulting in high VIF for some LPI coefficients (higher than ten). In order to find out whether trade in different product classes is more sensitive to different logistics performance sub-indices, we estimate our gravity model separately for each class of SNA: intermediate, capital and consumption goods. When choosing the estimator for our model, we had different possibilities, like standard ordinary least squares, fixed effects estimator or Poisson estimator.

Table 3.4. Summary statistics of the variable lpisub for EU15-ROW sub-sample

Variable	Mean	Std. Dev.	Min.	Max.	N
Customs	1.168	0.543	0	3.01	28575
Infrastructure	1.342	0.622	0	3.02	28575
International	0.899	0.486	0	2.88	28575
Logistics	1.198	0.560	0	2.89	28575
Tracking	1.191	0.581	0	3.05	28575
Timeliness	1.037	0.539	0	3.02	28575

Source: Author's own calculation

Table 3.5. Summary statistics of the variable lpisub for CEMS-ROW sub-sample

Variable	Mean	Std. Dev.	Min.	Max.	N
Customs	0.634	0.375	0	2.47	24765
Infrastructure	0.689	0.397	0	2.33	24765
International	0.564	0.375	0	2.29	24765
Logistics	0.624	0.371	0	2.26	24765
Tracking	0.66	0.421	0	2.43	24765
Timeliness	0.658	0.44	0	3.14	24765

Source: Author's own calculation

The gravity model can be estimated in several ways. There are more estimator suitable for gravity model estimation, for example, among linear estimators obvious choice is Ordinary Least Square (OLS), while among nonlinear estimators there is the Poisson Pseudo-Maximum Likelihood Estimator (PPML). Since the literature (Yotov 2016) suggests that the estimates prefer PPML over OLS, we chose and estimated Model 1 using Poisson Pseudo-Maximum-Likelihood Estimator (PPML), first introduced in gravity model setting by Santos Silva and Tenreyro (2006). We also used multilateral resistance terms introduced through fixed reporter and partner effects, thus following one of the seminal papers in this field of research, that of Anderson and van Wincoop (2004). That way we obtain consistent estimates of the gravity model variables, that are robust to different patterns of heteroscedasticity. Furthermore, by using PPML we are able to include zero trade flows, thus avoiding a source of bias. Estimates can be severely biased by incorrect treatment of zero trade flows (Baldwin and Taglioni 2006). In our data, there are 5.2% observations at country pair level with zero trade.

3.4. DATA

Our data consists of bilateral trade data between EU28 member countries and their trading partners, 157 countries in total. We distinguish between two groups within EU-28 countries: new EU member countries, that is all countries that became EU members since 2004 (CEMS) and old EU member countries (EU15). Source of bilateral trade data is UN Comtrade (2019) database. We obtained GDP data from World Bank Open Data (2019), while the data for other standard other standard gravity variables we obtained from CEPII database. Data for our main variable of interest, LPI sub-indices, came from World Bank. Table 3.1. presents descriptive statistics for standard gravity model variables, while as explained in Methodology section, Table 3.2. shows descriptive statistics of absolute differences of LPI sub-indices between trading partners for the full sample. Table 3.3. shows average trade value between trading dyads for three groups of countries that we define in our paper and from where we can observe the following: 1) EU15 intraregional trade is by far more developed in comparison with CEMS intraregional trade; 2) CEMS trade more with EU15 (interregional trade) than with other countries in CEMS; 3) EU15 is far more oriented toward trade with ROW in comparison with CEMS.

If we compare results of descriptive statistics in Table 3.4. with the results in Table 3.5., it is clear that EU15 have better logistics performance with respect to CEMS when comparing both groups with the ROW countries. We can use this difference as a proxy variable and argue that it reflects the difference between economic development levels between CEMS and EU15.

3.5. RESULTS AND DISCUSSION

Our results[2], presented in Tables 3.6.–3.11. show that variation in LPI sub-indices help explain variation in total trade, that is, the bigger the difference in LPI sub-indices, the lower the trade between trading partners. What is even more important, we find that there is heterogeneous impact of LPI sub-indices on trade, that is noticeable both in EU15-ROW and CEMS-ROW sub-samples and across all three classes of goods. Most negative and significant impact of an increase in LPI difference between trading partner is evident in the case of trade in intermediate goods between EU15 and ROW. This finding is in line with our expectations since almost two-thirds of global

[2] In results we present only estimates of the coefficients of LPI sub-indices. Size and significance of other gravity model variables included in Model 1 are mostly significant and have signs in line with theoretical predictions. Estimates of these coefficients are available upon request. Also, since presented results are obtained after estimating 180 models, we didn't show any goodness of fit statistics. Average coefficient of determination across all estimations, calculated as square value of the correlation between the predicted and the observed values of the dependent variable, is around 93%.

trade is in intermediate goods and trade in intermediate goods is closely connected with regional and global value chains that shape regional and global trade and global economy.

The results show that in the case of EU15-ROW trade, sub-indices Timelines, Tracking and International seems to have the highest negative effects on trade. Namely, the score gap in the sub-index the ease of arranging competitively priced shipments between trading partners (International) has the highest negative effect on trade on average, with its peak in 2016. Furthermore, the score gaps in the ability to track and trade consignments (Tracking) and timeliness of shipments with the expected delivery time (Timeliness) also affect trade significantly negative, especially for the period 2010 to 2014. The score gap in the quality of trade and transport infrastructure is not significant through the whole examined period, which is opposite to the economic literature where transport infrastructure is one of the most important trade promotors. The situation is slightly different in the case of trade in intermediate goods between CEMS countries and ROW.

Table 3.6. Estimation results of Model 1 for intermediate goods (EUR15-ROW)

Years	EU15-ROW (2010)	EU15-ROW (2012)	EU15-ROW (2014)	EU15-ROW (2016)	EU15-ROW (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs	-0.574***	-0.535***	-0.519**	-0.491**	0.243
	(0.146)	(0.147)	(0.171)	(0.186)	(0.186)
Infrastructure	-0.267	-0.355	-0.315	-0.357	0.421*
	(0.138)	(0.185)	(0.167)	(0.207)	(0.186)
International	-0.750***	-0.652**	-0.396	-1.232***	0.471
	(0.181)	(0.226)	(0.454)	(0.252)	(0.385)
Logistics	-0.537***	-0.494*	-0.363	-0.508*	-0.0346
	(0.154)	(0.204)	(0.222)	(0.229)	(0.246)
Tracking	-0.593**	-0.646**	-0.514**	-0.431	0.190
	(0.190)	(0.223)	(0.175)	(0.291)	(0.310)
Timeliness	-1.266***	-0.304	-1.087***	-0.0964	0.558
	(0.259)	(0.241)	(0.305)	(0.363)	(0.374)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	1815	1815	1905	1890	1875

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's own calculation

Table 3.7. Estimation results of Model 1 for intermediate goods (CEMS-ROW)

Years	CEMS-ROW (2010)	CEMS-ROW (2012)	CEMS-ROW (2014)	CEMS-ROW (2016)	CEMS-ROW (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs	-0.460**	-0.435*	-0.638*	-0.389***	-0.431**
	(0.168)	(0.206)	(0.253)	(0.117)	(0.149)
Infrastructure	-0.463**	-0.262	-0.199	-0.252	-0.599***
	(0.160)	(0.255)	(0.271)	(0.145)	(0.165)
International	-0.0582	-0.424*	-1.421***	-0.565***	-0.657***
	(0.217)	(0.199)	(0.272)	(0.137)	(0.142)
Logistics	-0.580*	-0.609*	-0.786***	-0.356**	-0.496***
	(0.234)	(0.266)	(0.220)	(0.138)	(0.125)
Tracking	-0.286	-0.819***	-0.512**	-0.359**	-0.459**
	(0.158)	(0.224)	(0.192)	(0.120)	(0.159)
Timeliness	-0.377**	-0.247	-0.303	-0.434**	-0.385*
	(0.141)	(0.167)	(0.218)	(0.144)	(0.182)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	1573	1573	1651	1638	1625

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's own calculation

The results of trade in intermediate goods are in line with the results of the previous works showing that most of sub-indices have significant effect on trade (Felipe and Kumar 2012; Marti, Puertac and Garcia 2014a; Puertas, Marti and Garcia 2014) while the results of trade in capital and consumption goods are inconclusive. These results lead us to the conclusion that logistics might be more important in trade in intermediate goods than in trade with capital and consumption goods. In the case of trade in capital and consumption goods the results are quite ambiguous.

Table 3.8. Estimation results of Model 1 for capital goods (EUR15-ROW)

Years	EU15-ROW (2010)	EU15-ROW (2012)	EU15-ROW (2014)	EU15-ROW (2016)	EU15-ROW (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs	-0.470**	-0.456**	-0.404*	-0.434*	-0.148
	(0.167)	(0.156)	(0.170)	(0.169)	(0.159)
Infrastructure	-0.273*	-0.373**	-0.120	-0.338*	0.0664
	(0.113)	(0.145)	(0.129)	(0.157)	(0.155)
International	-0.629***	-0.250	0.142	-0.310	0.283

	(0.174)	(0.257)	(0.246)	(0.293)	(0.344)
Logistics	-0.425**	-0.386*	-0.284	-0.533**	-0.317
	(0.158)	(0.177)	(0.194)	(0.197)	(0.211)
Tracking	-0.515**	-0.478**	-0.189	-0.437*	-0.0673
	(0.188)	(0.174)	(0.150)	(0.208)	(0.217)
Timeliness	-0.790**	-0.191	-0.284	-0.310	0.187
	(0.301)	(0.158)	(0.271)	(0.245)	(0.254)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	1815	1815	1905	1890	1875

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's own calculation

Table 3.9. Estimation results of Model 1 for capital goods (CEMS-ROW)

Years	CEMS-ROW (2010)	CEMS-ROW (2012)	CEMS-ROW (2014)	CEMS-ROW (2016)	CEMS-ROW (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs	-0.356*	-0.790**	-0.504	0.0997	-0.904**
	(0.151)	(0.264)	(0.438)	(0.249)	(0.325)
Infrastructure	-0.475***	-0.728*	0.290	0.113	-1.326**
	(0.139)	(0.337)	(0.286)	(0.364)	(0.435)
International	-0.186	-0.554	-1.671***	-0.439	-1.385***
	(0.242)	(0.344)	(0.399)	(0.257)	(0.304)
Logistics	-0.680**	-0.735*	-1.073*	-0.352	-0.702***
	(0.231)	(0.363)	(0.441)	(0.354)	(0.210)
Tracking	-0.394*	-0.555	-0.805*	-0.222	-0.489*
	(0.170)	(0.426)	(0.352)	(0.334)	(0.223)
Timeliness	-0.317*	-0.369	-0.771*	-0.0619	-0.156
	(0.141)	(0.242)	(0.319)	(0.245)	(0.226)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	1573	1573	1651	1638	1625

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's own calculation

In the case of trade in capital goods, the sub-indices Customs, International, Logistics and Tracking show the highest negative effects on trade in case of both EU15 and CEMS trade with the ROW. Unlike in the case of trade in intermediate goods, Timeliness is less important when it comes to the trade in capital goods since the nature of trade in capital goods is different due to several reasons. Supply of capital goods is limited due to the fact that 10 countries account for 80% of world capital goods production (Mutreja, Ravikumar and Sposi 2014). Also, demand is less elastic when compared with intermediate and consumption goods since buying capital goods is considered as a long-term investment.

In the case of trade in consumption goods, there is a clear distinction between estimations results for EU15-ROW vs CEMSROW. Namely, in the case of CEMS-ROW, the significance and the signs of the estimated coefficient are in line with our expectations, that is, the larger the LPI gap between trading partners, the lower the trade in consumption goods. On the other side, the significance, and the signs of the coefficients for the EU15-ROW case is counterintuitive; the coefficients are mostly not significant and are in some cases even positive, especially for the year 2018. We find the reason for these results in the economic development gap between EU15 and CEMS countries and that trade in consumption goods is mainly demand driven, while LPI sub-indices are supply-side oriented. Furthermore, we tested our model without GDP variable included and we obtained results that show that GDP differences between EU15 and CEMS with respect to their trading partners from the ROW countries could explain differences in results when it comes to trade in consumption goods.

Table 3.10. Estimation results of Model 1 for consumption goods (EUR15-ROW)

Years	CEMS-ROW (2010)	CEMS-ROW (2012)	CEMS-ROW (2014)	CEMS-ROW (2016)	CEMS-ROW (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs	-0.0813	0.288	0.138	0.245	0.588^{***}
	(0.161)	(0.162)	(0.135)	(0.171)	(0.160)
Infrastructure	-0.0105	0.0142	-0.0250	0.0709	0.588^{***}
	(0.121)	(0.192)	(0.167)	(0.190)	(0.162)
International	0.200	0.327	0.207	0.746^{*}	1.732^{***}
	(0.151)	(0.347)	(0.300)	(0.378)	(0.355)
Logistics	0.00606	0.156	-0.133	0.0164	0.718^{***}
	(0.153)	(0.243)	(0.225)	(0.262)	(0.172)
Tracking	-0.0872	0.0436	-0.504^{***}	-0.241	0.513
	(0.171)	(0.249)	(0.150)	(0.315)	(0.264)
Timeliness	-0.372	-0.0036	-0.362	0.338	1.006^{***}
	(0.245)	(0.293)	(0.277)	(0.323)	(0.272)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	1815	1815	1905	1890	1875

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author’s own calculation

Table 3.11. Estimation results of Model 1 for consumption goods (CEMS-ROW)

Years	CEMS-R (2010)	CEMS-R (2012)	CEMS-R (2014)	CEMS-R (2016)	CEMS-R (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs	-0.374**	-0.560*	-0.312	-0.179	-0.180
	(0.136)	(0.229)	(0.250)	(0.131)	(0.184)
Infrastructure	-0.578***	-0.450	-0.0402	-0.00129	-0.249
	(0.140)	(0.252)	(0.260)	(0.168)	(0.210)
International	-0.157	-0.277	-0.910**	-0.320*	-0.339
	(0.236)	(0.262)	(0.289)	(0.149)	(0.215)
Logistics	-0.736***	-0.700**	-0.720**	0.00692	-0.226
	(0.208)	(0.256)	(0.263)	(0.135)	(0.176)
Tracking	-0.409**	-0.588*	-0.375	0.0221	-0.259
	(0.135)	(0.287)	(0.194)	(0.120)	(0.178)
Timeliness	-0.438***	-0.402*	-0.397	-0.291	0.0449
	(0.118)	(0.186)	(0.213)	(0.151)	(0.194)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	1573	1573	1651	1638	1625

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's own calculation

Finally, since LPI index and its sub-indices are focused on supply chains, that is, they represent 'simple comparators of how efficiently supply chains connect firms to markets or logistics performance' (Arvis et al. 2018), we look at the EU15-ROW vs CEMS-ROW difference from regional and global supply chain perspective. We would like to stress out that in our paper we focus only on EU15 and CEMS trade with ROW, fully noting that regional supply chains within EU15 and between EU15 and CEMS have bigger importance to EU as a whole. Since it would be difficult to disentangle effects of LPI differences on intra-EU trade from other factors that affect strongly trade within EU, we focused only on trade of EU members with Third countries (ROW). When we compare effects of LPI differences on trade in the case of EU15-ROW vs CEMS-ROW trade, is seems that these differences had more negative impact on EU15-ROW trade in the aftermath of the Great Recession and particularly for trade in intermediates, where we observe significant negative effects across almost all subindices in 2010.

As the time passed, situation changed and in 2018 we observe that CEMS-ROW trade is highly affected by differences in logistics performance (Table 3.7.). This can be attributed to the fact that throughout the observed period, considerable gap between LPI index and its sub-indices of CEMS countries with respect to EU15 did not diminish. Moreover, based on previous findings (Baldwin and Lopez-Gonzalez 2015; Lejour, Rojas-Romagosa and Veenendaal 2017) in this field as well as statistical data of average bilateral trade flows of EU15-ROW versus CEMS-ROW showed in Table 3.3., we argue that EU15 countries are more immersed in global supply chains and that this is one of the reasons why they experienced larger negative effects of LPI differences in the aftermath of Global Recession as opposed to CEMS countries which are more immersed in regional supply chains and trade with EU15 and other countries of CEMS group of countries. Furthermore, as the EU15 countries are among top LPI performers, they mostly trade with the countries with lower logistics performance values, within the integration with CEMS, and outside the integration, with third countries. Results for most recent available year (2018) show that CEMS countries are not converging to EU15 when it comes to trade with ROW and that are probably still oriented toward regional supply chain, that can limit their competitiveness in globalized market of 21st century.

The results of the robustness check model (see Appendix B) confirm the hypothesis that there is a statistically significant relationship between logistics performance and bilateral trade, but the impact varies by logistics element (LPI sub-indices) and product group. The results show that a higher score on customs efficiency and border clearance of the reporting and partner country has significant and, in most years, positive effects on bilateral trade in all product groups. Infrastructure is less significant for trade in intermediate goods, but the ease of arranging shipping at competitive prices is highly significant and positive, especially for reporting countries in the case of trade in intermediate and consumption goods. The quality of logistics services is highly important for bilateral trade across all product groups and shows significant and positive results for reporting and partner countries. The ability to track the shipment is highly significant and positive for intermediate and consumption goods for partner countries, while it is highly significant and positive for capital goods for the reporting country. In contrast, timely delivery is highly significant and positive for partner countries in the case of trade in all product groups. Finally, most of the LPI sub-indices show higher significance in the later observed years, namely 2016 and 2018 due to the economic recovery after the 2009 crisis and favorable financial macroeconomic situation.

3.6. CONCLUSION

The aim of this paper was to investigate the effects of logistics performance, specifically different logistics functions on international trade in different classes of goods and to investigate possible differences within EU member countries. By incorporating LPI sub-indices, as proxy variables for logistics performance in the structural gravity model, we tried to investigate which of the logistical functions should be treated with priority and how the improvements in trade logistics affect specific product groups. Furthermore, we were interested about the effects of the difference in LPI on bilateral trade between two groups of countries, EU15 and CEMS countries with the rest of the world countries. We used EU15 as a benchmark for CEMS.

Our results support previously mentioned findings where logistics performance has statistically significant impact on bilateral trade flows. The results also show that difference in LPI sub-indices score between trading partners negatively affects trade, however this effect is different for different classes of goods. Namely, biggest negative effect of difference in the levels of LPI sub-indices between trading partners is noted in the case of trade in intermediate goods, meaning that intermediate goods are more sensitive to trade than capital or consumption goods, where it plays less prominent role. It is also quite interesting to observe that sub-indices like timeliness, tracking and international, which are in the domain of the private sector are more significant for trade in intermediate goods, while customs and infrastructure are more relevant to trade in capital goods. Our findings also show that LPI differences between trading partners for both groups of EU countries affect trade in intermediate goods more strongly, but it varies through different years. Global recession from 2008, had negative effect on global trade that hit harder EU15 countries, which are more oriented to global supply chains in comparison to CEMS. In the long term, in our case, from 2010 to 2018, EU15 stabilised trade flows with ROW, while CEMS are still very much oriented toward regional trade and regional supply chains, with LPI being significant hurdle in trade with ROW.

Several important policy implications flow from our results. We argue that CEMS countries need to put more effort in the development of trade logistics to converge with EU15 in the development of logistics services because it will remove bottlenecks, provide better transport corridors for trade, help reduce trading time, and increase the competitiveness of the shipment prices. Above all, logistics performance is a gather work for both, public and private sector and in order to improve logistics performance, countries and integrations must simultaneously work on changes in many areas, namely infrastructure, border procedures and regulatory environment, transport regulation and private sector development. Private sector development should be one of the priorities for CEMS, considering that its components affect trade in intermediate goods. That way, CEMS countries will have more chances of increasing participation in global supply chains.

We acknowledge that an important limitation of our research is estimations of our model on cross-section data. Although we had at our disposal biennial panel data, we decided to go along with cross-section estimation since, in our opinion, time period is too short for robust estimation results. As for the future research, with more LPI data available over the years, focus should shift on panel data analysis. Another possible contribution to this field of research is to downsize the analysis on sectoral or firm level. Finally, more thorough research of different product groups within different classes of goods (for example, within intermediate goods) could shed more light into relationship between trade and logistics performance.

4. ASSESSING THE EFFECTS OF HARD AND SOFT INFRASTRUCTURE ON TRADITIONAL VS SUPPLY-CHAIN TRADE: THE CASE OF CENTRAL AND EASTERN EU MEMBER STATES (CEMS)

Abstract

In this paper, we investigate the effects of trade facilitation on international trade. We aim to assess the role of hard and soft infrastructure in trade, distinguishing between traditional trade and supply-chain trade. Using factor analysis, we construct four aggregate indicators of trade facilitation where we measure hard infrastructure in terms of physical and ICT infrastructure, while soft infrastructure accounts for border efficiency and institutional efficiency. For traditional trade, we use bilateral trade data, available in the UN Comtrade (2020). Supply-chain trade is measured in terms of domestic value-added (DVAFX) embodied in foreign gross exports and foreign value-added (FVA) embodied in domestic gross exports obtained from Eora MRIO database. The empirical analysis is based on panel data regression analysis with an empirical model specification based on a gravity model and applied on gross trade. In case of supply chain trade, the gravity model is augumented to control for the technology development and the bilateral position, i.e. upstreamness in the supply chain. The analysis covers the 2000-2019 period. To deal with this issue of zero values, we use the Poisson Pseudo-Maximum Likelihood Estimator (PPML), while to control multilateral trade-resistance terms (MRT), we included reporter and partner fixed effects along with country pair fixed effects. Gravity model results confirm a statistically significant relationship between hard and soft infrastructure and trade. ICT and border efficiency have the strongest impact on both types of trade, whilst hard physical infrastructure bears the least impact on trade. Trade across supply chains responds most intensely to improvements in institutional efficiency. Furthermore, our results imply that ICT infrastructure and border efficiency might hold even greater importance for CEMS's traditional and supply-chain trade. The technological development of countries, which enables the production of higher valued and sophisticated products, and the upstream position in the supply chain have highly significant impacts on supply chain exports.

Keywords: trade facilitation, hard and soft infrastructure, bilateral trade, supply-chain trade, gravity model, upstreamness

4.1. INTRODUCTION

Trade liberalization reforms have led to a significant reduction in traditional trade barriers, i.e., tariffs and quotas, while other, non-tariff barriers and red tape remain and prevent the full realization of trade potential. Therefore, trade facilitation is an important topic in economic theory and one of the most intriguing trade policy issues. There is no universally accepted definition of trade facilitation; however, the generally accepted definition from the World Trade Organization (2012) states that trade facilitation is "the simplification and harmonization of international trade procedures, including the activities, practices, and formalities associated with the collection, presentation, communication, and processing of data and other information necessary for the movement of goods in international trade." In the empirical literature, the term is defined in a similar but simplified way: trade facilitation stands for the facilitation of cross-border trade in goods, especially efficient physical and telecommunication infrastructure, customs, other trade-related agencies, and logistics services (Felipe and Kumar 2012).

Trade facilitation is a "multi-faceted area" that encompasses any reform aimed at reducing the time and cost of trade. This multidimensionality of trade facilitation embodies both hard and soft infrastructure (Yadav 2014). By hard infrastructure, we mean physical infrastructure such as roads, railways, airports, seaports, and information and communication technology (ICT). On the other hand, soft or non-physical infrastructure includes the realm of all those elements behind and at the border that are directly or indirectly related to trade; for example, trade-related institutions, policies, rule of law, procedures, regulations, documentation, timeliness, etc. (Hernandez and Taningco 2010). Most of the existing literature focuses on the relationship between various elements of trade facilitation and traditional trade (Francois and Manchin 2007; Clark, Dollar and Micco 2004; Nordas and Piermartini 2004; Wilson, Mann and Otsuki 2003; Hernandez and Taningco 2010; Portugal-Perez and Wilson 2012; Maurel, Lapeyronie and Meunier 2016), ignoring the fact that traditional trade statistics are overestimated globally and are therefore less reliable and insufficient to measure real value flows between countries (Javorsek and Camacho 2015), especially since most international trade occurs through supply chains. Traditional trade often double-counts trade because it measures the total (gross) movement of goods and services whenever they cross the border and does not reflect how interconnected and interdependent countries (and their firms) are.

In contrast, trade across supply chains, usually measured as trade in value added, reflects a more realistic picture of trade while identifying the value-added content of countries' exports by netting out intermediate inputs, thus eliminating the frequent problem of double counting in traditional trade statistics (Saslavsky & Shepherd 2014). Considering that intermediate goods typically cross the border several times before becoming final goods, there are good reasons to believe that trade facilitation is relatively more important for supply chain trade than for traditional trade. The results of the firm-level analysis by Hoekman and Shepherd (2013) show that trade facilitation is beneficial for firms of all sizes, especially those primarily engaged in global value chain (i.e., supply chain trade). Improving trade facilitation allows countries to reduce trade fixed costs and participate in supply chain trade by trading certain activities and tasks in which they are competitive. Research by Saslavsky and Shepherd (2014) provides evidence that trade facilitation is more important for trade in global value chains than traditional gross trade. This argument is important for developing countries (such as CEMS) and their small-size firms that want to internationalize and benefit from it (Baldwin 2012). With this in mind, in this paper we aim to assess the role of hard and soft infrastructure in trade, distinguishing between traditional trade and supply chain trade. We want to find out which type of trade - traditional trade or supply chain trade - is more responsive to improvements in trade facilitation. We also aim to identify which specific component of trade facilitation is most important for promoting traditional trade and which is most important for promoting supply chain trade.

To the best of our knowledge, there is no previous study that differentiates the impact of hard and soft infrastructure on traditional trade versus supply chain trade, using data on trade in value-added. Our paper contributes to the existing literature in several ways. We distinguish trade facilitation effects between traditional and supply chain trade. We also estimate the impact of specific elements of trade facilitation (hard and soft infrastructure) on traditional trade and the supply chain. Finally, we estimate the impact of trade facilitation indicators when Central and Eastern EU Member States (CEMS) are among the trading partners to test whether there are specifics in this group of countries compared to the other countries in the sample. The motivation for the particular focus on the CEMS countries lies in the fact that the quality of transport infrastructure as an element of trade facilitation in these countries is below the EU average (European Commission 2014) and transport capacity is of great importance for small open economies like the CEMS to increase their international trade (Vlahinić Lenz, Pavlić Skender and Mirković 2018). Moreover, CEMS countries have been significantly involved in multilateral trade liberalization and regional integration efforts, and the share of most CEMS countries (with the exception of Cyprus and Croatia) in GVCs is above average according to the GVC Participation Index and occupies the downstream position, meaning their exports have a high import content (Grodzicki and Geodecki 2016; Bolatto et al. 2019; Kersan-Škabić 2019) and generates a lower value-added share (Van der Marel 2015). Therefore, we assume that hard and soft infrastructure is of foremost importance for the CEMS countries.

The remainder of the paper is organized as follows. Section 2 reviews the literature on the nexus between trade facilitation and international trade. The specification of the empirical gravity model is described in Section 3, while Section 4 presents the data and variables used in the analysis. Section 5 shows the estimates and discusses the results. Section 6 concludes the paper.

4.2. LITERATURE REVIEW

Since the 2000s, there has been growing interest in studying the impact of trade facilitation on international trade. The existing empirical literature on trade facilitation is mostly based on a gravity model, which is a standard approach to modelling bilateral trade flows, with Tinbergen (1962) and Pöyhönen (1963) making seminal contributions and, more recently, Anderson and van Wincoop (2004) providing an important addition to the theory. The standard specification of gravity model estimation typically includes gross domestic product to account for market size, distance between trading partners, and a number of different social and cultural characteristics. However, with the popularity of trade facilitation issues, researchers began to include various trade facilitation measures in the extended gravity equation (Devlin and Yee 2005; Behar and Manners 2008; Djankov, Freund and Pham 2010; Persson 2013; Behar and Venables 2011; Felipe and Kumar 2012; Host, Pavlić Skender and Zaninović 2019; Zaninović, Zaninović and Pavlić Skender 2021). However, the approaches used are not consistent in terms of the definition of trade facilitation.

The empirical literature (Wilson, Mann and Otsuki 2003, 2004; Portugal-Perez and Wilson 2012; Mirza and Bacani 2013; Yadav, 2014; Ismail and Mahyideen 2015) usually divides trade facilitation into two broader dimensions: hard infrastructure, which includes physical infrastructure such as seaports, airports, railways, roads, and information and communication technology (ICT), and soft infrastructure, which includes all intangible aspects of trade, procedures, regulations, documentation, logistics services, business environment, rule of law, institutions, etc. Researchers usually focus on one or more dimensions of trade facilitation measures. For example, Nordas and Piermartini (2004) examine the impact of quality infrastructure on total bilateral trade, distinguishing between total trade and trade in the apparel, automobile, and clothing sectors. As proxy variables for infrastructure, the authors use the quality of airports, roads, seaports, telecommunications, and the time required for customs clearance. The results of their gravity model suggest that the overall quality of infrastructure matters, while the quality of ports has the largest impact on trade. As for timeliness and access to telecommunications, they appear to be more important for trade in the apparel and automotive sectors.

Wilson, Mann, and Otsuki (2003) constructed four indicators of trade facilitation: Port Efficiency, Customs and Regulatory Environment, and E-business to estimate the impact of trade facilitation on trade among APEC economies from 1989 to 2000. Their analysis also relies on the gravity equation and shows that port efficiency has the strongest positive impact on trade. The customs environment and the use of e-business are positively associated with trade, while the regulatory environment has significant but strong negative effects on trade, contrary to expectations. The authors explain that regulation serves as a barrier to trade, although we believe that a better assessment of regulation should benefit trade. Soloaga, Wilson, and Mejia (2006) also use four indicators of trade facilitation: Port Efficiency, Customs and Regulatory Environment, and E-commerce, to examine the impact of changes in trade facilitation on total trade and trade for the main industrial sectors (food, beverages and tobacco, textiles, machinery other than transport equipment and transport equipment) in Mexico. The results of their gravity model show some unexpected results. Namely, port efficiency has a positive and significant impact on aggregate trade and across all sectors, for importers and exporters; however, the customs regulatory environment shows a negative and significant impact on trade at the aggregate level, including in the case of the sectors food, beverages and tobacco and transport equipment. The regulatory environment proves negative in the case of the transport equipment sector. E-commerce shows positive and significant impact on aggregate trade.

While the previously mentioned papers consider a broader definition of trade facilitation and use four dimensions of trade facilitation, Martínez-Zarzoso and Márquez-Ramos (2007) estimate the effect of trade facilitation on sectoral trade flows, while a proxy variable of trade facilitation uses the World Bank Doing Business (2020) database; specifically: cost, time and number of documents for import and export. Although results on the magnitude of the impact of trade facilitation vary across sectors and product groups, the common conclusion of the authors is that trade flows increase with reductions in transportation costs, number of days, and number of documents. Hernandez and Taningco (2010) examine behind-the-border measures affecting bilateral trade flows in East Asia using bilateral trade data on the Broad Economic Categories (BEC) 1-digit product classification. The authors use telecommunication services, quality of port infrastructure, trade time delays and depth of credit information as the main variables of interest, i.e. trade facilitation. The results also show variation across product groups and sectors, where, for example, time delays and quality of port infrastructure appear to have the strongest effects on trade in food and beverages and transport equipment. Maurel, Lapeyronie and Meunier (2016) examine how soft and hard infrastructure and diplomatic activities affect trade between the EU and African countries and CEMS and African countries over the period 2005-2012. The results show that the poor quality of hard and soft infrastructure in North African countries leads to trade diversion rather than trade creation.

Portugal-Perez and Wilson (2012) and Yadav (2014) build on the work of Wilson, Mann and Otsuki (2003) and estimate the impact of trade facilitation on bilateral trade. Their analysis incorporates four trade facilitation measures: physical infrastructure and information and communication technology as hard infrastructure, and business environment and border efficiency as soft infrastructure measures. Both papers use the gravity model with the OLS and PPML estimator, but on cross-sectional data for the period 2004-2007. Yadav (2014) goes a step further and distinguishes the impact of trade facilitation on trade in parts and components and manufactured goods in the case of the machinery and transport equipment sector. Portugal-Perez and Wilson (2012) argue that all trade facilitation variables have positive and significant effects on trade except for the business environment variable which is statistically significant but negative. Similarly, the results of Yadav (2014) show that the business environment variable has a negative impact on the import of parts and components. The authors note that this may not be unreasonable, as sometimes an inadequate regulatory environment and the practice of bribes stimulate trade, which we believe is not entirely true and the explanation may lie more in the dataset used for their analysis. Moreover, their results also suggest that trade facilitation is more important for trade in parts and components than for trade in final products. The results of Saslavsky and Shepherd's (2014) study also show that trade facilitation (in their case measured by logistics performance) has a stronger impact on trade in parts and components trade than on trade in final goods.

Methodology-wise, we build our research idea on the contributions of Wilson, Mann and Otsuki (2003), Portugal-Perez and Wilson (2012) Yadav (2014) but explore the impact of trade facilitation employing panel data analysis over a longer time period, i.e., from 2007 to 2015, and using alternative data sources for the institution variable. Moreover, this paper differs from the existing literature mainly in that we distinguish the impact of trade facilitation measures between traditional trade and value-added trade. Previous works (Yadav 2014; Saslavsky and Shepherd 2014) have used parts and components trade as a proxy for supply chain trade, but we believe that value-added trade data more realistically reflect supply chain trade than traditional disaggregated data. In the literature, supply chains are described as "a system of value-added sources and destinations", where within a supply chain each producer buys inputs and then adds value that is incorporated into the cost of the next stage of production (Koopman, Wang and Wei 2014).

However, the literature on supply chain trade is mainly empirical and there is no established model to rely on. The literature on supply chain trade is rapidly evolving (Kowalski et al. 2015, Vrh 2018), but in the absence of a common approach to modelling supply chain trade, we rely on existing research proposed by two parallel bodies of knowledge, one by Fally 2011; Antràs et al. 2012; Antràs and Chor 2013; Antràs and Chor 2018; Antràs and de Gortari 2020; Antràs 2020, and the other by Noguera 2012; Koopman et al. 2010 and Koopman, Wang and Wei 2014 and Timmer et al. 2014. Noguera (2012) was one of the first to study the determinants of bilateral value-added (VA) trade by deriving an approximate gravity equation and the results of estimation suggest that bilateral value added exports depend on the same bilateral gravity variables as bilateral gross exports, but the VA exports depend not only on bilateral gravity variables but also on gravity relations with third countries through which value added travels from the source to the final destination.

In the above mentioned empirical literature, there is general agreement that position, i.e., the upstream or downstream position of a country or its firms in a supply chain, is an important element of supply chain trade. The upstream position in the supply chain implies greater forward participation, while the downstream position implies greater backward participation. Therefore, it is important to control for the position of a country, industry, or firm in a supply chain when estimating the determinants of trade in the supply chain (trade in value added).

Another important factor that is expected to have a significant impact on supply chain trade is the technological development of countries. The logic behind this is that supply chain trade is a complex network of companies at different stages of production in different countries, and that technology is the essential factor that enables the supply chain to function. Countries that are more technologically advanced and have more knowledge are able to produce more complex products. In addition, the technological development of countries and their companies determines the country's position in the supply chain. However, this variable could also be endogenous, as trade in the supply chain also enables the transfer of technology and knowledge between countries (and their companies) involved in the supply chain (Antràs 2020).

Regarding our main variable of interest, i.e., hard and soft infrastructure factor variables, according to Antràs and de Gortari (2020), the quality of institutions and the political stability of the country are expected to be disproportionately more important for supply chain trade than for traditional trade, especially in terms of weak enforcement of contracts, which largely negatively affect supply chain trade. The empirical literature also argues that trade costs such as distances, inadequate transportation infrastructure, inefficient border clearance, and regulatory barriers can have a disproportionately negative impact on supply chain trade because, for example, a delay at any stage of the supply chain, whether due to inadequate infrastructure or slow clearance processes, affects the entire chain and raises prices not only for imported goods but also for further processing and exporting goods (Antràs 2020). Therefore, in this paper main focus is to estimate the impact of transport infrastructure, ICT infrastructure, institutions, and border efficiency to determine whether and to what extent these factors affect more traditional or supply chain trade.

4.3. EMPIRICAL GRAVITY MODEL

The empirical analysis is based on a panel data regression analysis with an empirical model specification built on the gravity model and applied to both gross trade and trade in value added. The gravity model is known as the "workhorse" of applied international trade analysis (Head and Mayer 2014). The gravity equation relates bilateral trade flows to GDP, distance, and other trade-related, political, social, and cultural factors that have an impact on trade (Anderson and van Wincoop 2004). However, there are several potential modelling and econometric problems in estimating the gravity equation. One of the most common problems is zero trade flows since much of the international trade matrix consists of zero trade. In our database, we observed 7% zero trade in import data and 13% zero trade in export data. If the standard log linear model is used to estimate the gravity model, the zero observations would drop out of the estimation and the information would be lost, leading to misleading results. One of the solutions to overcome the problem of zero trade is to estimate the gravity model using the Poisson Pseudo-Maximum Likelihood (PPML) estimator. Therefore, we use the PPML estimator proposed by Santos Silva and Tenreyro (2006) to solve the problem of zero trade values and heteroskedasticity. Indeed, in the presence of heteroskedasticity, the PPML is a robust approach. The PPML is a commonly used estimator in bilateral trade research (Martínez-Zarzoso and Márquez-Ramos 2007; Saslavsky and Shepherd 2014; Yadav 2014; Zajc Kejžar, Kostevc and Zaninović 2016; Zaninović, Zaninović and Pavlić Skender 2021, Zajc Kejžar and Velić 2020).

Another problem that often arises in estimating the gravity equation is the problem of endogeneity. Endogeneity can occur because the regressor is correlated with the error term and/or because some influential variable is omitted. If an influential variable is omitted from the estimation, this can lead to biased and inconsistent coefficient estimates (Baier and Bergstrand 2007). Endogeneity can also occur due to reverse causality. A typical example is that standard gravity variables are unlikely to be purely exogenous. To name a few; countries with higher GDP are more likely to trade, but the more countries trade, the higher their GDP. Another example of reverse causality is free trade agreements (FTAs). Countries that have signed a free trade agreement will trade more, but countries that trade a lot are also more likely to sign a free trade agreement. Trade costs are expected to have a negative effect on trade, but more trade can also lead to higher absolute trade costs (but lower unit costs). In this research there is also a possible endogeneity problem due to reverse causality of some regressors, namely factor variables. Physical infrastructure or ICT infrastructure is expected to facilitate and positively influence trade. However, it is also expected that countries that trade frequently will invest more in improving roads, ports, ICT networks, etc. It is also expected that efficient customs clearance procedures will lead to more trade. But again, the more countries trade, the more likely they are to sign free trade agreements, the fewer trade documents will be needed, and the faster and more efficient border clearance procedures will be.

It is not simple to deal with endogeneity bias. Baier and Bergstrand (2007) argue that, for example, unobserved time-invariant bilateral variables that are likely to be correlated with the regressors, such as FTAs, are the source of endogeneity bias in the gravity model. To address this issue, Baier and Bergstrand (2007) recommend using a panel data analysis with country-pair fixed effects, country fixed effects, and time fixed effects, which we include in our estimation. To control for multilateral trade resistance terms (MRT) we use country (reporter and partner) fixed effects and country pair fixed effects, as also suggested in Hummels (2001), Olivero and Yotov (2012), Yotov et al. (2016), and Feenstra (2016). Another possible solution to deal with endogeneity is to use lagged values of the regressors, which we also include in our estimation. A widely preferred solution to deal with the endogeneity would be the use instrumental variables (IV approach) developed by the Hausman and Taylor in 1981 (Yotov 2016), but the problem with the IV approach is that is hard to find the instruments that are correlated with the regressors but not with trade.

Therefore, our econometric model for the traditional trade is specified in the following way:

$$IT_{ijt} = \exp(\alpha + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 FTA_{ij} + \beta_4 lndistw_{ij} + \beta_5 hardinf_{it} + \beta_6 hardinf_{jt} + \beta_7 hardict_{it} + \beta_8 hardict_{jt} + \beta_9 institution_{it} + \beta_{10} institution_{jt} + \beta_{11} border_{it} + \beta_{12} border_{jt} + \lambda_t + \eta_{ij} + \varphi_i + \pi_j + u_{ijt}) \quad [4.1],$$

where IT_{ijt} represents the value of bilateral trade in US dollars between reporting country *i* and partner country *j* in year *t*. We estimate two separate equations of our traditional trade separately for (1) gross imports and separately for (2) gross exports. The rest of the model (explanatory variables) remains the same for both equations. $LnGDP_{it}$ is the reporter's log-transformed gross domestic product in year *t*, while $lnGDP_{jt}$ is the partner's log-transformed gross domestic product in year t. FTA_{ij} is a dummy variable with value one if there is a free trade agreement between the trading partners and with value zero if not. $Lndistw_{ij}$ represents the distance between the capitals of the trading partners. $Hardinf_{it}$ and $hardinf_{jt}$ represent the quality of the hard physical transport infrastructure of the reporting (i) and partner (j) countries in year t, respectively. The variables $hardict_{it}$ and $hardict_{jt}$ represent the quality of the hard ICT infrastructure of reporting (i) and partner country (j) in year t. $Institution_{it}$ and $institution_{jt}$ represent the soft infrastructure - institutional efficiency of reporting (i) and partner country (j) in year t. The variables $border_{it}$ and $border_{jt}$ represent the soft infrastructure - border efficiency of reporting (i) and partner country (j) in year t. The construction of these institutional variables is explained in the next section. Terms $\lambda_t + \eta_{ij} + \varphi_i + \pi_j$ represent time fixed effects, country pair fixed effects, and reporter and partner fixed effects.

Our econometric model for value-added trade is specified as follows:

$$VAT_{ijt} = \exp(\alpha + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 FTA_{ij} + \beta_4 lndistw_{ij} + \beta_5 hardinf_{it} + \beta_6 hardinf_{jt} + \beta_7 hardict_{it} + \beta_8 hardict_{jt} + \beta_9 institution_{it} + \beta_{10} institution_{jt} + \beta_{11} border_{it} + \beta_{12} border_{jt} + \beta_{13} technology_{it} + \beta_{14} technology_{jt} + \beta_{15} upstreamness_{it} + \lambda_t + \eta_{ij} + \varphi_i + \pi_j + \mathrm{u}_{ijt} \quad [4.2],$$

where VAT_{ijt} represents the value of trade in value added in US dollars between reporting country i and partner country j in year t. We estimate two separate equations of trade in value added (3) foreign value added embodied in gross domestic exports (FVA), which refers to backward participation in global value chains, and as an (4) domestic value added embodied in gross foreign exports (DVAFX), which refers to forward participation in global value chains. The regressors are the same as in traditional model [4.1], however in this model we also control for the technological development of trading partners and the upstreamness, that is position in the supply chain. Hence, variables $technology_{it}$ stands for the technological development of reporting country i in year t while $technology_{jt}$ stands for the technological development of partner country j in year t. $upstreamness_{it}$ denotes the position of the country i in year t in the supply chain. As in equation [4.1], terms $\lambda_t + \eta_{ij} + \varphi_i + \pi_j$ represent time fixed effects, country pair fixed effects, and reporter and partner fixed effects respectively.

In both models [4.1] and [4.2], we use country-pair clusters to account for the correlation of error terms within country-pairs. Neglecting correlation within panel units can lead to severely underestimated standard errors (Moulton 1990 in Shepherd, Doytchinova and Kravchenko 2019, p. 22). To reduce possible endogeneity concerns, all explanatory variables are lagged by one year.

Because there is little literature focusing on the Central and Eastern European EU member states, those countries still have a systematically lower share of domestic value added in exports compared to the EU-15 countries (Vrh 2018, p. 646),we estimate the effects of trade facilitation variables (four factor variables) in interaction with dummy variables for the Central and Eastern European EU member states to observe if the effects of hard and soft infrastructure matter more for trade in these countries.

The empirical literature (Antràs 2020) argues that hard and soft infrastructure variables may have a disproportionately negative impact on supply chain trade than on traditional trade, so we focus on these variables in this study. However, we must acknowledge that causality may also work in the other direction (as explained in Section 4.2) and this may be a source of endogeneity bias in our results. However, the aim of this reserach is to investigate whether and to what extent hard and soft infrastructures are responsible for the improvement of traditional trade and supply chain, and not to determine the existence of a direct causal relationship between dependent and independent variables.

4.4. DATA AND VARIABLES

Our data include bilateral trade data between 130 reporting countries and 131 partner countries and cover the period from 2000 to 2019. For traditional trade, imports and exports, we use bilateral trade data available at UN Comtrade (2020). As proxy variables for supply chain trade, we use Eora MRIO trade indicators, mainly foreign value added (FVA) embodied in gross domestic gross exports (as equivalent for imports) and domestic value added (DVAFX) embodied in gross foreign gross exports (as equivalent for exports), obtained from the Eora MRIO (2020) Global Value Chain (GVC) database. We obtained gross domestic product (GDP) data, free trade agreement data, and distance data from the CEPII (2019) database.

We use the Economic Complexity Index (ECI) developed by the Harvard Growth Lab as a proxy variable for the technological development of the trading partner. The Economic Complexity Index ranks countries based on the diversity and complexity of their export products. Countries that rank high on the Complexity Index produce "a highly diversified set of complex products" due to their specialized and developed capabilities (Harvard's Growth Lab 2021).

The countries can participate in the supply chain forward (FP) and backward (BP), which means that in case of forward participation, the country participates in global production by exporting domestically produced inputs to partners responsible for downstream production stages, while in case of backward participation, the country participates in the production of goods and services for export by importing foreign inputs. Backward linkages are measured as foreign value added (FVA) embodied in domestic exports, while forward linkages are measured by domestic value added embodied in foreign exports (DVAFX). Thus, the FVA in exports tends to be larger for more downstream positioned countries, while DVAFX previlas in case of more upstream position in GVCs. The calculation of the upstreamness is done with Koopman et al. (2010) in the background, where in the first step we calculate a) forward participation (FP) and b) backward participation (FP) using the following equation:

a) $FP = (DVAFX_{ijt}/exports_{it}) * 100$ [4.3],

b) $BP = (FVA_{ijt}/exports_{it}) * 100$ [4.4].

In the second stage, we calculate the bilateral supply chain position, i.e., c) upstreamness based on the following equation:

c) $upstreamness_{ijt} = ln((1+FP)/100) - ln((1+BP)/100)$ [4.5].

To represent the bilateral supply chain position of the countries, we use the logarithmic ratio of a country's forward and backward participation, as suggested by Koopman et al. (2010). The higher the value of the ratio, the higher the upstream position of a country in the supply chain. This measure characterises the relative upstreamness of a country by comparing the importance of forward and backward participation. We adjust the supply chain position measure to be country-pair specific by using bilateral participation indices that we specified in eq. [4.3] and eq. [4.4] to obtain a bilateral supply chain participation index (eq. [4.5]).

For our main variables of interest, trade facilitation indicators (hard and soft infrastructure), we used different sources. Hard physical infrastructure indicators, i.e., *Quality of air transport* *infrastructure, Quality of port infrastructure, Quality of roads,* and *Hard ICT infrastructure*; *Availability of latest technologies*, *Firm-level technology absorption*, and *Government procurement of advanced technology* are obtained from the World Economic Forum (2020) Global Competitiveness Report.

The soft infrastructure – institutional efficiency indicators *Voice and Accountability*, *Political Stability and Absence of Violence, Government Effectiveness*, *Regulatory Quality*, *Rule of Law*, and *Control of Corruption* come from the Worldwide Governance Indicators (2020). From the World Bank's Doing Business database come the indicators for soft infrastructure - border efficiency, specifically *Number of documents to import and export* and *Number of days to import and export*.

This means that the original data sample (hard and soft infrastructure) includes 16 indicators (shown in Figure 4.1.). Considering that our database was not complete, i.e., values were not available for certain years, we extrapolated hard physical infrastructure data and hard ICT infrastructure data for 2000-2006 and 2018-2019 and Doing Business data for 2000-2004 and 2016-2019. We performed a robustness check on the extrapolated data by comparing the results of the full sample with the extrapolated data and the original data. We found that the difference in the estimated coefficients was not significant.

We use a simple linear extrapolation, i.e., the following equation:

$$y = \frac{y_1 - y_0}{x_1 - x_0}(x - x_0) + y_0 \quad [4.6],$$

where *y* is the respective Doing Business and WEF indicator and *x* is a specific year.

Figure 4.1. Aggregate indicators and their sub-indicators

Hard physical infrastructure	Hard ICT infrastructure
Quality of air transport infrastructure Quality of port infrastructure Quality of roads	Availability of latest technologies Firm-level technology absorption Government procurement of advanced technology
Soft infrastructure – institutional efficiency	**Soft infrastructure – border efficiency**
Voice and Accountability Political Stability and Absence of Violence Government Effectiveness Regulatory Quality	Number of documents to export Number of documents to import Number of days to export Number of days to import

Source: Authors' elaboration

Since there are a variety of hard and soft infrastructure indicators, we constructed four aggregate "synthetic" indicators that represent hard infrastructure divided into physical infrastructure and ICT infrastructure, and soft infrastructure divided into institutional efficiency and border efficiency. Based on the approach of Portugal-Perez and Wilson (2012), we used Confirmatory Factor Analysis (FA) to construct our four aggregate indicators. FA is a statistical technique that describes the variability between observed correlated variables and reduces the number of these variables to a smaller number of factors. FA extracts the maximum common variance from the observed variables and loads it into a single factor. The final loading factors related to each initial variable are shown in Table 4.1. Table 4.1 also shows the percentage of variance described by each of the identified factors.

Table 4.1. Hard and soft infrastructure variables – loading factors

	Hard physical infrastructure			
Cumulative variance				
	Reporter country		Partner country	
Factor	Variance	Proportion	Variance	Proportion
Physical infrastructure	2.27480	1.0855	2.27252	1.0852
Factor loadings				
Variable	Factor1	Uniqueness	Factor1	Uniqueness
Quality of air transport infrastructure	0.8756	0.2333	0.8873	0.2128

Quality of port infrastructure	0.8930	0.2025	0.8874	0.2124
Quality of roads	0.8430	0.2893	0.8353	0.3023

Hard ICT infrastructure

Cumulative variance				
	Reporter country		Partner country	
Factor	Variance	Proportion	Variance	Proportion
ICT infrastructure	1.88978	1.0187	1.90422	1.0576
Factor loadings				
Variable	Factor1	Uniqueness	Factor1	Uniqueness
Availability of latest technologies	0.8083	0.2639	0.8140	0.2704
Firm-level technology absorption	0.7457	0.1580	0.7715	0.1741
Government procurement of advanced technology	0.3724	0.5784	0.4061	0.6092

Soft institutional efficiency

Cumulative variance				
	Reporter country		Partner country	
Factor	Variance	Proportion	Variance	Proportion
Institutional efficiency	4.36837	0.8789	4.15419	0.8351
Factor loadings				
Variable	Factor1	Uniqueness	Factor1	Uniqueness
Voice and Accountability	0.3978	0.3197	0.3984	0.2912
Political Stability and Absence of Violence	0.3388	0.3755	0.2670	0.3741
Government Effectiveness	0.8166	0.0439	0.7898	0.0508
Regulatory Quality	0.7339	0.0839	0.7364	0.0822
Rule of Law	0.6447	0.0331	0.5842	0.0350
Control of Corruption	0.6635	0.0676	0.5950	0.0765

Soft border efficiency

Cumulative variance				
	Reporter country		Partner country	
Factor	Variance	Proportion	Variance	Proportion
Border efficiency	2.43624	0.7955	2.46582	0.7860
Factor loadings				
Variable	Factor1	Uniqueness	Factor1	Uniqueness
Number of documents to export	0.2339	0.2437	0.2326	0.2266
Number of documents to import	0.2058	0.2548	0.1886	0.2496
Number of days to export	0.8213	0.1324	0.8391	0.1100
Number of days to import	0.8035	0.1244	0.8227	0.1069

Source: Authors' calculation

Table 4.2. reports descriptive statistics for all variables included in the model for all observed countries, while table 4.3. reports descriptive statistics for all variables for CEMS countries. We report summary statistics on the synthetic indicators of hard and soft infrastructure centered on zero. In tables 4.2. and 4.3. we report descriptive statistics in levels.

Table 4.2. Descriptive statistics (all countries in dataset)

Variables	N	Mean	Std. Dev.	Minimum	Median	Maximum
Imports_*ij*	293538	3.38e+09	2.75e+10	0	3.08e+07	2.25e+12
Exports_*ij*	293538	3.15e+09	2.63e+10	0	2.39e+07	1.92e+12
FVA_*ij*	145023	247641.08	2.02e+06	0	1537.425	1.14e+08
DVAFX_*ij*	145023	275057.96	2.29e+06	0	1392.731	1.10e+08
gdp_*i*	292523	5.28e+08	1.75e+09	860550.3	6.67e+07	2.14e+10
gdp_*j*	290997	4.79e+08	1.66e+09	409000	5.69e+07	2.14e+10
distw_*ij*	293405	7241.68	4336.073	14.136	6891.347	19650.13
FTA_*ij*	293405	0.20	0.399	0	0	1
hardinf_*i*	218096	-0.04	1.056	-3.605202	-.077425	2.470529
hardinf_*j*	213029	0.03	1.026	-3.731677	-.0347256	5.13958
hardict_*i*	218096	-0.01	1.236	-4.322591	-.0052789	2.419836
hardict_*j*	213029	0.04	1.208	-5.144729	.0435262	2.636351
institution_*i*	293538	0.03	1.047	-2.552114	-.100453	3.297704
institution_*j*	293538	0.14	0.982	-2.148115	.0170444	3.086314
border_*i*	221952	-0.02	1.048	-1.506536	-.3295802	5.255601
border_*j*	219193	-0.10	0.930	-1.910626	-.3692232	4.499719
technology_*i*	293538	0.16	0.974	-2.7013	.0559	2.8242
technology_*j*	293421	0.04	0.996	-2.7989	-.0746	2.8242
upstreamness	145023	0.00	0.000	-.0009062	-3.69e-10	.0041776

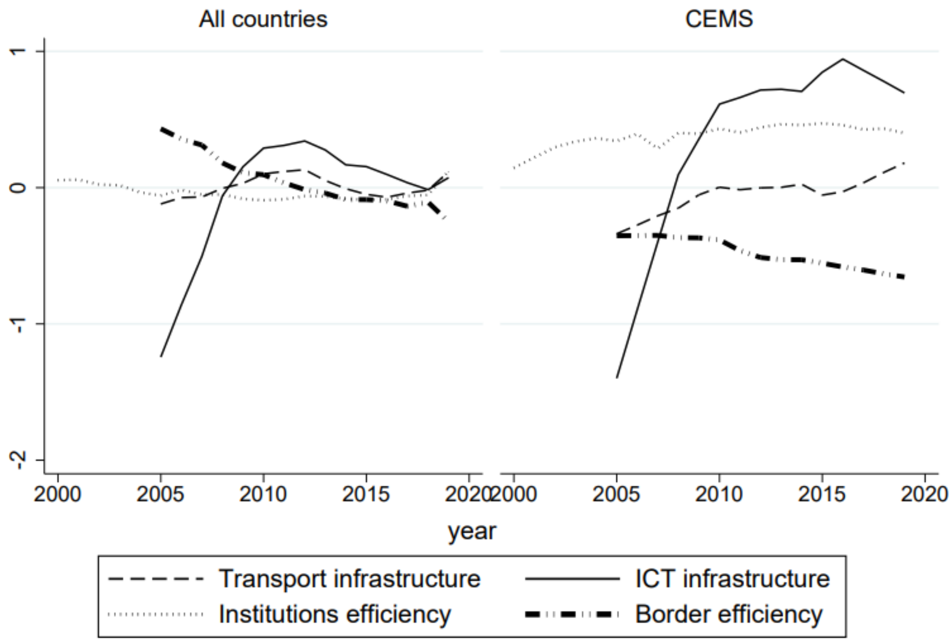
Source: Author’s calculation

Table 4.3. Descriptive statistics (CEMS countries - reporters)

Variables	N	Mean	Std. Dev.	Minimum	Median	Maximum
Imports_*ij*	31085	1.49e+09	7.37e+09	0	2.72e+07	2.40e+11
Exports_*ij*	31085	1.42e+09	7.99e+09	0	3.39e+07	2.95e+11
FVA_*ij*	14180	167517.91	8.91e+05	2.069859	4170.53	1.89e+07
DVAFX_*ij*	14180	128770.85	8.57e+05	5.462865	1463.582	2.58e+07
gdp_*i*	30695	9.67e+07	1.19e+08	5685561	5.02e+07	5.92e+08
gdp_*j*	30812	4.66e+08	1.64e+09	409000	5.31e+07	2.14e+10
distw_*ij*	31073	5369.59	3792.670	55.136	4752.306	18192.7
FTA_*ij*	31073	0.35	0.478	0	0	1
hardinf_*i*	23384	-0.08	0.631	-1.528624	.0592553	1.463174
hardinf_*j*	22141	0.01	1.031	-3.731677	-.0620116	5.13958
hardict_*i*	23384	0.32	0.956	-2.476336	.5521894	1.789835
hardict_*j*	22141	0.02	1.215	-5.144729	.0091302	2.636351
institution_*i*	31085	0.37	0.504	-1.088074	.4535571	1.646978
institution_*j*	31085	0.12	0.985	-2.148115	-.0077213	3.086314
border_*i*	21433	-0.46	0.441	-1.308141	-.3291028	.2894363
border_*j*	22859	-0.08	0.953	-1.910626	-.3613313	4.499719
technology_*i*	31085	0.99	0.461	.1046	.9197	1.8504
technology_*j*	31075	0.02	0.993	-2.7989	-.1063	2.8242
upstreamness	14180	-0.00	0.000	-.0000329	-8.18e-09	.0000279

Source: Authors' calculation

Figure 4.2. The development of the infrastructure variables – all countries vs. CEMS, 2000-2019



Source: Authors' work

Figure 4.2. presents the dynamics of the average hard and soft institution variables for all countries in the sample (left panel) and separately for CEMS countries as reporting countries (right panel). The hard physical infrastructure variable has been improving at an above average rate for the group of CEMS. The hard ICT infrastructure variable, in case of CEMS is above the average of all countries, however, in both cases it has been worsening in the recent years. The soft border variable shows trend of improvement both for all countries and CEMS indicating declining number of days and required documents for trade, with CEMS values being below the total sample average. Finally, CEMS exhibit an above average value of institution variable compared to total average, however, stagnation has been observed on the last few years.

4.5. RESULTS AND DISCUSSION

The following tables show the results obtained from the estimation of the structural gravity model. Pooled ordinary least squares estimates (POLS) are given in Table 4.4. POLS usually provides biased estimates; however, it is often used as a benchmark for other estimators, and we present its results to compare the coefficients obtained with the estimator Poisson Pseudo-Maximum Likelihood (PPML). The estimates from the PPML estimator, our preferred estimator, are presented in Table 4.3. In Tables 4.2. and 4.3., each column shows the results of the separate estimation of models [4.1.] for the following dependent variables: Gross Imports (1), Gross Exports (2), and the results of the separate estimation of models [4.2.] for the following dependent variables: Foreign Value Added (FVA) embodied in Domestic Gross Exports (3), and Domestic Value Added (DVAFX) embodied in Foreign Gross Exports (4). We tested the equality of regression coefficients since we estimated the model on different samples. The *p value* was statistically significant (0.000) and thus we reject the H_0 that coeffcients are equal.

Table 4.4. Results of the POLS regression: traditional vs. supply-chain trade, 2000–2019

VARIABLES	(1) lnimports	(2) lnexports	(3) lnFVA (SC imports)	(4) lnDVAFX (SC exports)
lngdp_*i*	0.540***	-0.0208	-0.504***	0.477***
	(0.0439)	(0.0539)	(0.0238)	(0.0197)
lngdp_*j*	0.365***	0.541***	0.600***	-0.258***
	(0.0431)	(0.0424)	(0.0177)	(0.0204)
1.fta_wto_*ij*	0.385***	0.437***	0.279***	0.259***
	(0.0552)	(0.0522)	(0.0283)	(0.0280)
lndistw_*ij*	-1.584***	-1.836***	-0.810***	-0.829***
	(0.0367)	(0.0356)	(0.0219)	(0.0223)
hardinf_*i*	0.0408	0.233***	0.0819***	0.0267***
	(0.0255)	(0.0277)	(0.00945)	(0.00738)
hardinf_*j*	0.0698**	0.0718***	0.0366***	0.0444***
	(0.0284)	(0.0222)	(0.00844)	(0.00893)
hardict_*i*	-0.0305*	0.0282	-0.0414***	-0.0109*
	(0.0172)	(0.0196)	(0.00519)	(0.00628)
hardict_*j*	0.0840***	0.00361	0.0159***	-0.0318***
	(0.0189)	(0.0155)	(0.00561)	(0.00616)
institution_*i*	0.123***	0.157***	0.0397***	0.0827***
	(0.0319)	(0.0346)	(0.00995)	(0.0110)
institution_*j*	0.0366	0.0282	-0.00838	0.0537***

	(0.0369)	(0.0358)	(0.0143)	(0.0151)
border_*i*	0.0124	-0.218***	-0.00738	-0.0508***
	(0.0219)	(0.0259)	(0.00715)	(0.00769)
border_*j*	-0.111***	0.0150	-0.0230***	-0.0521***
	(0.0257)	(0.0236)	(0.00794)	(0.00919)
technology_*i*			0.269***	0.0280**
			(0.0180)	(0.0129)
technology_*j*			0.0126	0.0536***
			(0.0103)	(0.0119)
upstreamness			-34,584***	61,244***
			(7,882)	(6,877)
Constant	9.290***	21.63***	10.90***	7.408***
	(1.109)	(1.224)	(0.566)	(0.518)
Time FE	YES	YES	YES	YES
Reporter FE	YES	YES	YES	YES
Partner FE	YES	YES	YES	YES
Observations	90,318	85,780	98,270	98,270
R-squared	0.763	0.758	0.927	0.926

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculation

Comparison of the coefficients from Table 4.4. with those from Table 4.5. confirms that in the case of a data sample consisting of zero trade values, standard estimation procedures are likely to be downward biased as suggested in the literature (Felipe and Kumar 2012). Therefore, further discussion of the results will focus on the PPML estimates (Table 4.5.).

Consistent with the theory of gravity model, the size of economies, measured by the logarithm of GDP of trading partners, has a positive effect on traditional trade flows. In the case of supply chain trade, the logarithm of the reporting country's GDP has a positive and statistically significant impact on supply chain exports (forward participation in GVCs), while the impact on supply chain imports (i.e., backward participation in GVCs) is not significant, and conversely, the logarithm of the partner country's GDP has no significant impact on supply chain exports but is significantly positive in the case of supply chain imports. In the supply chain trade, higher income countries are expected to have higher value-added production, and thus higher value added exports. The same logic could be applied to imports in the supply chain, measured as foreign value added embodied in domestic exports, where higher income countries are capable to attract foreign value added and include it in their further production. However, in supply chain trade there is no straightforward relationship between trading partners as in traditional trade, and in this dataset we do not have accurate information on the exact country of origin of foreign value embedded in domestic exports and vice versa.

The existence of a free trade agreement (FTA) between trading partners is contrary to our expectation, as the coefficients are insignificant, although in theory the trade agreement between trading partners should lead to higher trade volumes. The reason behind could be that out of all the observations (dyads), about 17% of FTAs are in force during the observed period (2000-2019) and out of these "FTA dyads" 15.39% are within EU integration. Although the percentage of "FTA dyads" in our sample is relatively high, only 0.96% of FTAs entered into force during the observed period. We argue that this is the reason why the FTA variable is not significant. The distance variable "distance" was omitted from the analysis because we included country-pair fixed effects in our estimation.

Our main variables of interest, hard and soft infrastructure, show interesting patterns. In the case of hard physical infrastructure, the results imply that hard physical infrastructure is among other trade facilitation elements, the least important for traditional and supply chain trade. The results show that the quality of reporter country physical infrastructure has significantly positive effects on traditional exports while the quality of a partner country physical infrastructure has significantly positive impact on foreign value added in gross domestic exports, that is supply chain imports. In contrast, a reporter country's hard ICT infrastructure is highly significant and positive for traditional exports and imports and supply chain imports. However, the results also show significant negative effects of partner country ICT infrastructure on supply chain imports. Although it may appear that ICT infrastructure is supporting supply chain trade, new ICT technologies may have implications for the relative bargaining power of different supply chain participants. Large buyers in wealthy countries may use ICT infrastructure to obtain information about a larger number of potential suppliers, increasing their ability to make those suppliers compete with one another. As a result, the largest companies in wealthy countries may benefit from better terms of trade, while producers in less developed countries receive a smaller share of the benefits of supply chain trade (Antràs 2020). The results also suggest that the quality of institutional efficiency matters more for supply chain trade than for traditional trade, which is consistent with our expectations since supply chain trade is the result of complex network linkages that require a strong institutional background. Border efficiency still plays an important role and, as we expected, the results point to negative effects of trade. Namely, the results imply that an increase in the number of documents and days for exporting and importing will lead to a deterioration of traditional exports and traditional and supply chain imports. The more documents required for export or import, the longer it takes to complete the necessary customs procedures for trade. According to Islam and Amin (2015), lower-income countries take more time to trade than higher-income countries because higher-income countries can devote more resources to efficient documentation systems compared to lower-income countries countries.

In the supply chain trade estimation, we control also for the technological development of the countries and bilateral position in the supply chain, that is aggregate upstreamness. The more the countries are technologicaly developed there are capable to produce more complex product and thus add more value to the production and be positioned more upstream in the supply chain. Our results imply that the improvement in technological development of reporter countries has significant positive effects on supply chain exports, namely domestic value added in foreign exports, but on the other hand, significantly negative effect on supply chain import, that is foreign value added in domestic exports. These results indicate that higher technologicaly developed countries are more forward participation oriented in the supply chain.

Table 4.5. PPML regression results: traditional vs. supply-chain trade, 2000–2019

Variables	(1) Imports	(2) Exports	(3) FVA (SC imports)	(4) DVAFX (SC exports)
lngdp_*i*	0.611***	0.447***	0.0139	0.502***
	(0.0484)	(0.0573)	(0.0313)	(0.0588)
lngdp_*j*	0.361***	0.397***	0.432***	-0.00638
	(0.0452)	(0.0557)	(0.0331)	(0.0393)
1.fta_wto_*ij*	0.0417	0.0457	0.0321	0.0310
	(0.0344)	(0.0374)	(0.0217)	(0.0521)
hardinf_*i*	0.0207	0.0421*	-0.00870	-0.000438
	(0.0204)	(0.0239)	(0.0213)	(0.0189)
hardinf_*j*	0.00424	-0.0321	0.0457***	0.0343
	(0.0313)	(0.0261)	(0.0149)	(0.0229)
hardict_*i*	0.0313*	0.0323**	0.0299*	0.0210
	(0.0172)	(0.0154)	(0.0164)	(0.0169)
hardict_*j*	0.0374*	0.0273	-0.0371***	-0.0116
	(0.0221)	(0.0182)	(0.0118)	(0.0138)
institution_*i*	0.0174	0.0103	0.0160	0.0942***
	(0.0277)	(0.0330)	(0.0203)	(0.0233)

institution_*j*	-0.00403	0.0218	0.0676***	0.0648***
	(0.0314)	(0.0258)	(0.0216)	(0.0248)
border_*i*	-0.0771***	-0.137**	-0.120***	-0.0346*
	(0.0257)	(0.0651)	(0.0303)	(0.0203)
border_*j*	-0.00657	-0.135***	-0.0581***	-0.0208
	(0.0567)	(0.0381)	(0.0211)	(0.0333)
technology_*i*			-0.0946***	0.0581***
			(0.0344)	(0.0184)
technology_*j*			0.00184	0.0326
			(0.0213)	(0.0691)
upstreamness			-30,597***	13,966***
			(2,357)	(2,945)
Constant	4.251***	6.773***	6.084***	4.864***
	(1.379)	(1.328)	(0.858)	(1.356)
Time FE	YES	YES	YES	YES
Reporter FE	YES	YES	YES	YES
Partner FE	YES	YES	YES	YES
Country pair FE	YES	YES	YES	YES
Observations	97,964	96,918	98,270	98,270

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculation

To explore further the eventual specifics of the CEMS with respect to the relevance of the hard and soft infrastructure for trade, PPML estimates with interaction effects included are shown in Table 4.6. Namely, we included interaction effects of the CEMS dummy variable (which has a value of 1 if a reporting or partner country is a member of Central and Eastern EU) with our factor variables, namely hard and soft infrastructure variables. We have included variable distance and independent CEMS dummy in the estimation, but the variables were omitted from the analysis because of the fixed effects included in our estimation.

Table 4.6. PPML regression results: traditional trade vs supply-chain trade, 2000–2019 (hard and soft infrastructure variables in interaction with the CEMS dummy)

VARIABLES	(1) Imports	(2) Exports	(3) FVA (SC imports)	(4) DVAFX (SC exports)
lngdp_*i*	0.625***	0.454***	0.0193	0.503***
	(0.0482)	(0.0580)	(0.0312)	(0.0588)
lngdp_*j*	0.373***	0.401***	0.440***	-0.00193
	(0.0472)	(0.0563)	(0.0333)	(0.0406)
1.fta_wto_*ij*	0.0482	0.0516	0.0372*	0.0324
	(0.0346)	(0.0373)	(0.0218)	(0.0514)
c.CEMS_*i* #c.hardinf_*i*	-0.0720**	-0.0676*	0.0132	0.0294
	(0.0308)	(0.0378)	(0.0588)	(0.0313)
c.CEMS_*j* #c.hardinf_*j*	-0.107**	-0.164***	-0.0352	-0.0778**
	(0.0514)	(0.0573)	(0.0356)	(0.0339)
hardinf _*i*	0.0291	0.0459*	-0.00565	1.84e-05
	(0.0194)	(0.0245)	(0.0221)	(0.0198)
hardinf_ *j*	0.00517	-0.0219	0.0466***	0.0411*
	(0.0330)	(0.0274)	(0.0154)	(0.0239)
c.CEMS_*i* #c.hardict_*i*	0.0388*	0.0605***	0.0601***	0.0103
	(0.0222)	(0.0164)	(0.0120)	(0.0138)
c.CEMS_*j* #c.hardict_*j*	0.217***	0.0162	0.0518***	0.0934***
	(0.0344)	(0.0388)	(0.0171)	(0.0209)
hardict_*i*	0.0219	0.0217	0.0199	0.0198
	(0.0175)	(0.0157)	(0.0172)	(0.0173)
hardict_*j*	0.0197	0.0206	-0.0431***	-0.0217
	(0.0224)	(0.0189)	(0.0120)	(0.0151)
c.CEMS_*i* #c. institution_*i*	0.117	0.137**	0.0687*	-0.119**
	(0.0715)	(0.0671)	(0.0391)	(0.0497)
c.CEMS_*j* #c. institution_*j*	-0.0263	0.0834	-0.120***	-0.0154
	(0.0727)	(0.0896)	(0.0427)	(0.0616)
institution_*i*	0.00279	0.00151	0.00520	0.0945***
	(0.0270)	(0.0330)	(0.0205)	(0.0237)
institution_*j*	-0.0117	0.0154	0.0679***	0.0607**
	(0.0316)	(0.0261)	(0.0219)	(0.0255)
c.CEMS_*i* #c.border_*i*	-0.196***	-0.275***	-0.131	-0.0361
	(0.0622)	(0.0848)	(0.0864)	(0.0540)
c.CEMS_*j* #c.border_*j*	-0.611***	-0.368***	-0.179**	0.0822
	(0.124)	(0.108)	(0.0790)	(0.104)
border_*i*	-0.0554**	-0.0965	-0.0746***	-0.0316
	(0.0263)	(0.0708)	(0.0256)	(0.0202)
border_*j*	0.00358	-0.126***	-0.0515**	-0.0158
	(0.0570)	(0.0394)	(0.0209)	(0.0338)
technology_*i*			-0.101***	0.0580***

			(0.0343)	(0.0185)
technology_*j*			-0.00564	0.0114
			(0.0216)	(0.0709)
upstreamness			-30,445***	14,041***
			(2,255)	(2,970)
Constant	3.726***	6.577***	5.873***	4.778***
	(1.408)	(1.361)	(0.863)	(1.363)
Time FE	YES	YES	YES	YES
Reporter FE	YES	YES	YES	YES
Partner FE	YES	YES	YES	YES
Country pair FE	YES	YES	YES	YES
Observations	97,964	96,918	98,270	98,270

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculation

The significant negative interaction terms for hard physical infrastructure and the CEMS dummy for traditional trade indicate that hard physical infrastructure has a significantly more negative impact on traditional trade in the new member states than in the old. However, no significant difference is found for supply chain trade between the old and new member states, with the exception of the impact of partner country hard physical infrastructure on supply chain exports (DVAFX). We would expect improvements in physical infrastructure to have a positive effect on trade, or at worst to be insignificant but have a negative sign, because improvements in physical infrastructure usually lead to lower transportation and thus trade costs, which benefits trade. Further research on this topic could therefore address this issue.

When it comes to ICT infrastructure, it plays even more important role for CEMS trade as the interaction coefficients are highly significant and positive for both traditional and supply chain trade. The results imply that border efficiency in interaction with CEMS has significant negative effects on traditional exports and imports and supply chain imports. While institutions generally have a significant positive impact on supply chain trade, the sign of the coefficient becomes negative when we include the CEMS dummy variable interacting with the institutions variable. This means that CEMS institutions have a negative impact on supply chain trade, but on the other hand, they have a positive impact on traditional trade, especially exports.

The results suggest that the number of documents and days for import and export have significantly higher impact in CEMS trade compared to other countries in our sample. The CEMS countries are generally more focused on regional trade with most trade occurring within the European Union. CEMS are also more likely to be involved in regional rather than global supply chains. This claim is supported by several empirical papers (Elekdag and Muir 2015; Sobański 2015; Capello and Perucca 2015; Damijan and Kostevc 2011; Kulbacki and Michalczuk 2021). Recent findings of Zaninović, Zaninović and Pavlić Skender (2021) show that CEMS are mainly involved in regional trade, primarily with EU15 countries and secondarily between other CEMS countries. The EU15 countries, on the other hand, trade mainly with the EU15 and then with the CEMS countries, and their trade with third countries is ten times higher than the CEMS trade with third countries, namely outside the EU integration. These results suggest that the EU15 countries are more globally oriented than the CEMS countries, which trade mainly with countries within the integration. Moreover, Bresslein and Huber (2016) analyse the trade patterns of EU countries focusing on supply chain trade and show that developed countries, i.e. EU15 countries, trade mainly with other developed countries, while less developed EU countries (CEMS) trade with more developed countries (EU15).

4.6. CONCLUSION

The purpose of this research was to assess the role of hard and soft infrastructure in traditional trade and supply chain. Our intent was to examine which type of trade, traditional trade or supply chain trade, is more responsive to improvements in which specific component of trade facilitation. Nearly two-thirds of trade involves intermediate goods that typically cross the border several times before becoming final goods. Considering that trade in intermediate goods typically takes place within complex supply chains, trade facilitation plays an important role in this. These findings are particularly important for countries that want to engage in trade, especially in supply chain networks, or that want to boost their trade through improvements in trade facilitation.

The main contribution of this research lies in the identification of a specific component of trade facilitation that is most important for promoting traditional trade and that is most important for promoting supply chain trade. Our results suggest that hard physical infrastructure is less important as a trade facilitator. The reason for this could be that hard infrastructure is already at a higher level of development and has reached a steady state in many of the countries studied. We consider hard infrastructure as the "older" trade facilitator, while ICT infrastructure, on the other hand, is still in the development stage. ICT infrastructure play an important role in improving trade, especially traditional trade, while institutional efficiency seems to be more important for supply chain trade. Border efficiency plays important role in both, traditional and supply chain trade. However, ICT infrastructure and border efficiency are even more relevant for CEMS countries, where ICT seems to promote both traditional and supply chain trade, while border efficiency is mainly responsible for the growth of traditional trade.

From a policy perspective, the results of this paper are intended to contribute to the understanding of the potential gains in traditional trade and supply chain by improving certain elements of trade facilitation. The results presented here are intended to stimulate discussion among policymakers and stakeholders to make an initial prioritization of their trade facilitation efforts. We note that our results are subject to some limitations. First to deal with the endogeneity issue, this research would benefit to perform the instrumental variable (IV) regression. The follow up research could include the instruments that induces changes in the regressors but has no independent effect on the traditional or supply chain trade variables. Given the limited trade facilitation data, we constructed four trade facilitation variables. However, further work could be made to construct other measures of trade facilitation to cover its broad spectrum. There is no single measure that would cover all aspects of trade facilitation, but the choice of indicators depends on the preferences of the researchers. The selection of indicators produced could be expanded to a broader range of trade facilitation, such as other "behind the boarder" measures, institutional efficiency measures, connectivity measures and logistics and other trade related services. Moreover, analysis of the impact of trade facilitation at the firm level could provide a more insightful contribution to the current state of knowledge on trade facilitation. These limitations offer potential starting points for further research.

5. CONCLUSIONS

The aim of this dissertation was to empirically examine the various effects of transport infrastructure, logistics performance and related trade facilitation indicators on international trade and economic growth through three interrelated research papers. For this purpose, this dissertation is made as a collection of three separate and interrelated research papers.

The focus of the first research paper was on the rail and road transport infrastructure and its impact on economic growth in the case of the Central and Eastern European EU Member States (CEMS). The motivation for this research lies in the fact that the CEMS countries have experienced the hard transition from planned to market economies and are constantly lagging behind the older EU Member States, namely the EU15 countries. EU authorities usually consider transport infrastructure as an important tool to reduce these development disparities, remove bottlenecks and achieve economic, social and territorial cohesion in the EU. Therefore, a significant part (around 22.4 billion EUR in the period 2014-2020 according to UNIFE 2018) of the EU budget is spent on the construction and renovation of transport infrastructure in the EU and the development of Trans-European Transport Network (TEN-T). In addition, the EU promotes the idea of shifting a large part of traffic from road to rail in order to reduce greenhouse gas emissions. However, railway infrastructure in the EU is generally in poor condition, especially in the CEMS countries, which is why the construction and renovation of railway lines is a priority in EU transport and infrastructure policy.

From a theoretical and empirical point of view, the relationship between transport infrastructure and economic growth has been studied in the literature for decades, but the results of testing this relationship are not conclusive. While seminal paper of Aschauer (1989), grounded on neoclassical theory, where he analysed and estimated aggregate production function generally support the positive and significant impact of infrastructure on output, the other stream of empirical literature does not find these propositions theoretically and empirically justified, especially in the case of the EU (such as the work of Crescenzi and Rodríguez-Pose 2012). Therefore, the aim of the first research paper of the dissertation was to re-examine the question of the impact of rail and road transport infrastructure on economic growth in CEMS countries in the period from 1995 to 2016. Two empirical econometric models were used in the first research paper of this dissertation. The first model included a set of standard variables that generally have an impact on economic growth, such as investment in infrastructure, population growth, trade openness, and the variables we were most interested in, the length of railways and motorways. Additional model (model two) followed the established methodology in macroeconomic analysis, namely the aggregate production function, and included the variables output per worker, total factor productivity, physical capital and as in the first model, the transport infrastructure variables; length of railways and motorways. The research was based on panel data analysis and both models were estimated using a fixed effects estimator. In the dissertation are also employed several robustness check estimations of the original model that control for the other type of infrastructure, airport and seaport infrastructure which are important part of external EU trade. The results of the estimation of first model indicate the positive effects of road infrastructure on economic growth, together with other control variables such as investments in infrastructure, population, and trade openness. The results of the second model, aggregate production function estimated with fixed effects estimator, and additionally estimated with Generalized Methods of Moments (GMM) show that among all observed types of infrastructure, only road infrastructure shows positive and significant effects on the output.

Even though the results of our estimations do not support the idea of the significant relationship between transport infrastructure (at least not railway, seaport and airport infrastructure) the general opinion supports the EU position that transport and its infrastructure are at the heart of economic and social development and that improving transport infrastructure should reduce inequalities between old and new EU Member States. However, there are required additional investigations of the other factors that might benefit the EU cohesion. After all, transport and infrastructure are public policies that, as Adam Smith argued, are of public interest and in which governments should invest to achieve other development goals.

The question arises whether there are other factors related to transport infrastructure that can promote economic growth and help the CEMS countries to converge to the EU15 countries in terms of economic growth and development. Therefore, the second research paper in this dissertation focused on the impact of logistics performance on international trade of the two blocks of countries, CEMS and EU15. Logistics performance includes various components of logistics such as trade and transport infrastructure, customs, competitive prices for shipments, logistics services, the ability to track shipments, and timely delivery of shipments. All these aspects of logistics performance can have a significant impact on international trade and are likely to stimulate international trade, especially exports and hence economic growth.

However, the theoretical and empirical literature in this area is relatively new and there is a gap in the empirical literature, especially in the context of CEMS countries. The aim of the second paper was therefore to examine the impact of each logistics component on international trade in different classes of goods and to identify possible differences within EU member countries, i.e. between CEMS and EU15 countries. The logistics performance index and its sub-components were used as proxy variables for logistics performance. This study is based on the theory of Tinbergen's (1962) gravity model and includes the main variable of interest, logistics performance, in addition to the standard gravity variables gross domestic product, distance, contiguity and common language. The motivation was to investigate, on the one hand, which of the logistical components should be prioritised, taking into account trade in certain product groups, and on the other hand, the impact of logistical performance between two groups of countries, the EU15 and the CEMS countries with the rest of the world.

Methodologically, the absolute differences in the values of gross domestic product and logistics performance subcomponents between trading partners are used as regressors. Reported and partner country fixed effects are also included in the model. The model was estimated using Poisson Pseudo-Maximum-Likelihood Estimator (PPML). The results confirm the stated hypothesis and indicate that logistics performance has a statistically significant impact on international trade and that the larger the differences in logistics performance values between trading partners, the more negatively trade is affected. Since the intuition of the gravity model is that the absolute size of the economy affects bilateral trade, to check the robustness of the original model, the gravity model was estimated in which the regressors are expressed in levels. The results of the robustness check of the model also confirmed the results of the original model. Furthemore, the results of the descriptive statistics show that EU countries trade mainly within integration, which means that their trade is more regional. However, EU15 countries trade most with each other and then with CEMS countries. Considering that the EU15 countries are among the top performers in terms of the logistics performance index and the CEMS countries are average, this is also one of the reasons why most trade takes place between developed countries and then between developed and developing countries. Looking at trade in different product groups, e.g., intermediates, capital goods, and consumer goods, the results of this analysis show that intermediates are the most sensitive to logistics performance and that, of the six observed components of logistics performance, the ability to track shipments, timely delivery, and ease of arranging shipments at competitive prices most affect trade in intermediates. These results suggest that the components attributable to the private sector are more relevant to intermediate trade. From a practical perspective, private firms should invest in their information and communication technology to enable efficient tracking of shipments and ensure timely delivery of goods. Logistical performance is a joint effort between the private and public sectors, and the government should also support private companies with soft infrastructure, for example, by reducing regulations and procedures necessary for cross-border trade and ensuring that institutions operate efficiently and transparently. Considering that about two-thirds of trade is in intermediate goods, which are usually transacted through supply chains, these findings offer relevant insights and suggestions for improving trade logistics and trade facilitation elements to ensure higher levels of trade, especially for CEMS countries.

The current theoretical and empirical literature on trade facilitation is relatively sparse and there is no standard measure of trade facilitation. The most commonly used trade facilitation indicators are either the Logistics Performance Index, which was used in the second research paper of this dissertation, or the construction of trade facilitation indicators, often referred to as hard and soft infrastructure indicators. Accordingly, the aim of the third research paper in this dissertation was to continue the second research and evaluate the role of hard and soft infrastructure in traditional trade and supply chain trade. Since hard infrastructure includes physical transportation and ICT infrastructure and soft infrastructure includes intangible aspects of trade such as institutions, regulations, and procedures, this research created four synthetic indicators that represent these aspects of trade facilitation. As an additional contribution to existing evidence, this study estimated which type of trade-traditional trade or supply chain trade-is more responsive to improvements in which specific component of hard and soft infrastructure (trade facilitation). As noted earlier, nearly two-thirds of trade is in intermediate goods, which typically cross the border several times before becoming final goods and occurs within complex supply chains. Hard and soft infrastructure, or trade facilitation, plays an important role in this. The analysis is based on the gravity model specification and was estimated using PPML. According to the research findings, hard physical infrastructure is less important than soft infrastructure in facilitating trade. ICT infrastructure and border efficiency are essential factors in improving trade, particularly traditional trade, while institutional efficiency appears to be more crucial for supply chain trade. For CEMS countries, ICT infrastructure and border efficiency are even more important, as ICT seems to increase both traditional and supply chain trade, while border efficiency is more responsible for the growth of traditional trade. Overall, the results support the third hypothesis of this dissertation, which is that trade facilitation, i.e. hard and soft infrastructures, have a positive impact on traditional and supply chain trade, with different elements of trade facilitation bearing different degree of relevance for traditional and supply chain trade.

The limitations of the research are that the data analysed in all three research papers are at the aggregate, national level. Better insights into the true impact of transport infrastructure and logistics performance would be possible if we had firm-level data that would allow us to account for more of the heterogeneity across panel entities. In addition, the first research paper used proxy variables for transport infrastructure, which are already established in the literature, but quantity of transport infrastructure cannot substitute for quality and perhaps additional measures of transport infrastructure quality would contribute to research. The data on logistics performance used in the second research paper refer to a short period and contain only biennial information. In the future, a longer period would allow panel data estimations to be carried out instead of cross-sectional analyses. In the third research paper, trade facilitation indicators were constructed based on the available secondary data. However, trade facilitation can be analysed in a narrower or broader sense, and there is a wide range of indicators available to the researcher that could be used. Future research could focus on constructing different trade facilitation indicators that encompass other aspects of trade facilitation and also include instrumental variables to avoid potential bias in results that are not addressed in this dissertation.

This dissertation contributes to the existing body of knowledge in several ways. There is a lack of empirical literature addressing the impact of transport infrastructure on economic growth in Central and Eastern European Member States. Therefore, this dissertation brings together and tests the existing literature on transport infrastructure and economic growth. The results of this dissertation contribute to a better understanding of the role of transport infrastructure in the European economy.

This dissertation also contributes to the theory of international trade from the perspective of logistics. According to the existing body of knowledge, it is the first time that differences in logistics performance between trading partners in trade in different product groups are empirically investigated, specifically for trade between EU15 and CEMS countries.

In addition to the theoretical contribution, these results are also important for practical application. The research results provide policy makers and businesses with important information on the factors that can help them promote their trade, integrate into supply chains and diversify their exports. Knowing which element of logistics has the greatest impact on trade in a given product group makes an important contribution to trade policy making at the national and firm level. Finally, the main contribution of this dissertation is to identify a specific component of trade facilitation, hard and soft infrastructure, that is most important for promoting traditional trade and that is most important for promoting supply chain trade. Countries and firms should focus on removing trade bottlenecks in the supply chain because facilitating trade within supply chains has positive multiplier effects on economic growth, domestically, regionally, and globally.

Current empirical literature uses either logistics performance or hard and soft infrastructure indicators to analyse their impact on trade. However, this dissertation is the first that an analysis is conducted from both perspectives, i.e., logistics performance and other trade facilitation measures. It is also the first attempt to contrast the effects of trade facilitation on traditional and supply chain. Supply chain trade is analysed in this dissertation through the prism of value-added trade rather than traditional gross trade, which is also a first and a contribution to the existing empirical literature. The findings of the dissertation contribute to the understanding of the potential gains in traditional trade and supply chain trade by improving certain elements of trade facilitation. The findings presented in this dissertation provide support and guidance to policy makers and private sector stakeholders, particularly in CEMS countries, on which elements of trade facilitation need to be prioritised to ensure efficient trade and consequently economic growth.

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APPENDIX A: Chapter 2

Table A1. Description of the variables

	Notation	Variable	Description	Source
Dependent variable	*gdp_growth*	Economic growth	Annual % change of GDP	Eurostat
Independent variables	*pop_growth*	Population growth	Annual % change of population	
	gfcf_growth	Investment's growth	Annual % change of gross fixed capital formation	
	open_growth	Trade openess growth	Annual % change of trade openness ratio	
	rail_growth	Rail infrastructure	Annual % change of total transport of freight in million tonne-kilometre (tkm)	
	road_growth	Road infrastructure	Annual % change of total transport of freight in million tonne-kilometre (tkm)	
	seaport_growth	Seaport infrastructure	Annual % change of total transport of freight in thousand tonnes	
	airport_growth	Airport infrastructure	Annual % change of total transport of freight in million tonne-kilometre (tkm)	
	ruleoflaw_growth	Institutions	Annual % change of Rule of law indicator	World bank - World Governance Indicators
	hcpi_growth	Monetary factors	Annual % change of harmonized consumer price index	Eurostat
	financial_growth	Financial development	Annual % change of Financial development index	IMF
	employment_growth	Employment growth	Annual % change of total employment – resident population concept	Eurostat
	technology_growth	Technology	Annual % change of Economic complexity index	Harvard's Growth Lab

Source: Author's elaboration

Table A2. Descriptive statistics of all variables in the models [A1]-[A4]

Variable	N	Mean	Std. Dev.	Minimum	Median	Maximum
gdp_growth	273	7.35	8.315	-26.71738	7.200806	35.13681
pop_growth	273	-0.20	0.865	-4.498464	-.1659958	2.786945
gfcf_growth	273	8.42	18.749	-65.84811	7.687385	123.1564
open_growth	273	2.41	8.235	-25.55488	1.830942	43.53424
rail_growth	138	-0.57	10.566	-32.9853	-.2787934	24.62891
road_growth	153	4.98	11.987	-39.23934	5.811208	30.72995
seaport_growth	149	2.80	9.879	-28.46724	3.283701	42.88895
airport_growth	104	1.83	13.256	-50	.0432152	50
ruleoflaw_growth	154	10.51	120.251	-465.3844	.7019828	1342.27
financial_growth	252	2.46	10.784	-38.3547	1.441226	82.31676
hcpi_growth	245	26.93	586.964	-3210	-17.36842	8100
employment_growth	91	0.31	2.406	-5.413499	.678674	5.87156
technology_growth	252	3.90	27.339	-77.97895	1.060611	287.2432

Source: Author's calculation

The following models are a modified version of the model [2.1.] and serves as an additional robustness check. We run four separate estimations where we gradually add additional variables to the original model to observe for potential changes in estimates. All the variables are converted into growth rates (annual % change). The four models have following structures:

$$gdp\_growth_{it} = \beta_0 + \beta_1 pop\_growth_{it} + \beta_2 gfcf\_growth_{it} + \beta_3 open\_growth +_{it} \beta_4 rail\_growth_{it} + \beta_5 road\_growth_{it} + \lambda_t + u_{it} \quad \text{[A1],}$$

$$gdp\_growth_{it} = \beta_0 + \beta_1 pop\_growth_{it} + \beta_2 gfcf\_growth_{it} + \beta_3 open\_growth +_{it} \beta_4 rail\_growth_{it} + \beta_5 road\_growth_{it} + \beta_6 seaport\_growth_{it} + \lambda_t + u_{it}$$

[A2]

$$gdp\_growth_{it} = \beta_0 + \beta_1 pop\_growth_{it} + \beta_2 gfcf\_growth_{it} + \beta_3 open\_growth +_{it} \beta_4 rail\_growth_{it} + \beta_5 road\_growth_{it} + \beta_6 seaport\_growth_{it} + \beta_7 airport\_growth_{it} + \lambda_t + u_{it} \quad \text{[A3],}$$

$$gdp\_growth_{it} = \beta_0 + \beta_1 pop\_growth_{it} + \beta_2 gfcf\_growth_{it} + \beta_3 open\_growth +_{it} \beta_4 rail\_growth_{it} + \beta_5 road\_rowth_{it} + \beta_6 seaport\_growth_{it} + \beta_7 airport\_growth_{it} + \beta_8 ruleoflaw\_growth_{it} + \beta_9 financial\_growth_{it} + \beta_{10} hcpi\_growth_{it} + \beta_{11} employment\_growth_{it} + \beta_{12} technology\_growth_{it} + \lambda_t + u_{it} \quad [A4].$$

where dependent variable is GDP growth measured as annual percentage change of gross domestic product. All the regressors are converted into the growth rates (annual % change).

The regressors in equations [A1]-[A4] are: population growth (*pop_growth*), gross fixed capital formation growth (*gfcf_growth*), trade openness ratio growth (*open_growth*) and growth of railway (rail_growth) and road (*road_growth*) total freight transport expressed in million tonnes per kilometre – tkm. The *i* denotes the cross-sectional unit (country) and *t* the time period (year).

In equation [A2] we added seaport infrastructure proxied by the total sea freight transport expressed in thousand tonnes (*seaport_growth*) as a regressor.

In equation [A3] we added airport infrastructure proxied by the total air freight transport expressed in million tonnes per kilometre – tkm (*airport_growth*) as a regressor.

In equation [A4] we added other regressors to control for the effects on economic growh; rule of law, which is a proxy variable for institutions (*ruleoflaw_growth)*, financial development index growth (*financial_growth*), proxy variable for financial development, harmonized consumer price index, proxy variable for monetary factor (*hcpi_growth*), employment growth (*employment_growth*) and economic complexity index growth, proxy variable for technology (*technology_growth*).

Variable λ_t denotes the time (yearly) fixed effects and u_{it} is the error term.

The results of the estimation of the models [A1] – [A4] with fixed effects (FE) estimator are reported in table A3.

Table A3. Results of the FE estimation, 1995 – 2016

VARIABLES	(A1) gdp_growth	(A2) gdp_growth	(A3) gdp_growth	(A4) gdp_growth
pop_growth	0.324	0.523	-0.926	-1.067
	(0.930)	(1.134)	(1.515)	(1.108)
gfcf_growth	0.280***	0.290***	0.340***	0.212**
	(0.0419)	(0.0484)	(0.0409)	(0.0759)
open_growth	-0.248*	-0.254	-0.328**	-0.260*
	(0.121)	(0.148)	(0.100)	(0.117)
rail_growth	-0.0118	-0.0189	-0.0580	0.00870
	(0.0184)	(0.0254)	(0.0388)	(0.0333)
road_growth	0.0458	0.0726**	0.0455	-0.00139
	(0.0306)	(0.0258)	(0.0382)	(0.0753)
seaport_growth		0.0365	0.0404	0.108
		(0.0350)	(0.0600)	(0.0597)
air_growth			0.0440	0.0552
			(0.0389)	(0.0395)
ruleoflaw_growth				0.0188**
				(0.00713)
financial_growth				-0.174
				(0.128)
hcpi_growth				-0.000150
				(0.000200)
employment_growth				0.191
				(0.359)
technology_growth				0.0131
				(0.0453)
Time Fixed Effects	YES	YES	YES	YES
Constant	8.548***	5.711**	-5.858*	5.880**
	(2.310)	(1.724)	(2.712)	(2.164)
Observations	131	92	64	49
R-squared	0.900	0.920	0.914	0.828
Number of Country	11	8	8	7

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculation

APPENDIX B: Chapter 3

As a robustness check of the model (3.1.), we develop the following model:

$$trade_{ijt} = \beta_0 + \beta_1 gdp_{it} + \beta_2 gdp_{jt} + \beta_3 dist_{ij} + \beta_4 lpisub_{it} + \beta_5 lpisub_{jt} + \beta_6 contig_{ij} + \beta_7 comlang_{ij} + \beta_8 RTA_{ijt} + \beta_9 fx_{it} + \beta_{10} fx_{jt} + \sum_{i=1}^{k} \delta_i + \sum_{j=1}^{k} \gamma_j + u_{ijt} \qquad [B1],$$

where $trade_{ijt}$ is the value of bilateral trade (imports + exports) in the first estimation and the value of exports between reporting country *i* and partner country *j* in year *t* in the second estimatation (in US dollars). Reporting country *i* are 28 EU member countries (*i* goes from 1 to 28), while partner country *j* are 28 EU member countries and the remaining trading partners in the world *(j* goes from 1 to 157). The sampe consist of 157 partner countries in total, however for the years 2010 and 2012 only 152 partner countries are included in the sample as the LPI was only collected for these countries. *t* represents the years 2010, 2012, 2014, 2016 and 2018. gdp_{it} and gdp_{jt} represents the absolute size of GDPs of the reporting country *i* and partner country *j* (in current US dollars) in year *t*. $dist_{ij}$ represents the geographical distance between the capitals of the trading partners. $lpisub_{it}$ and $lpisub_{jt}$ represents the value of the LPI sub-indices (separately for each of the six sub-indices) of the reporting county *i* and partner country *j* in year *t*. $contig_{ij}$ is a dummy variable with value one if the trading partners share a land border and zero if not. $comlang_{ij}$ is a dummy variable with value one if the countries have a common main official language, and zero if not. RTA_{ijt} is a dummy variable with value one if the countries have signed a (regional) free trade agreement, and zero if not. fx_{it} and fx_{jt} represent the nominal effective exchange rate index of reporting country *i* and partner country *j* in year *t*.

The nominal exchange rate is expressed by the number of foreign currency units per national currency. Thus, an increase corresponds to an appreciation of the domestic currency against the foreign currency. With these definitions, a real (nominal) appreciation of the domestic currency is captured as an increase in the real (nominal) effective exchange rate index (Couharde et al. 2018).

The regressors are standardized by subtracting the sample mean and dividing by the standard deviation. The model is, as the original one, estimated using Poisson Pseudo Maximum Likelihood (PPML) estimator. The results of the estimation of the impact of logistics performance on bilateral trade (measured as total value of trade; imports+exports) between EU28 Member States and their trading partners (rest of the world - ROW) are presented in Tables B1 - B3 separately for trade in intermediate, capital and consumption goods. The results of the estimation of the impact of logistics performance on bilateral trade (measured as total value of exports) are presented in Tables B4 - B6, again separately for intermediate, capital and consumption goods.

Table B1. Estimation results of robustness check model for intermediate goods (EU28-ROW)

	EU28-ROW	EU28-ROW	EU28-ROW	EU28-ROW	EU28-ROW
Years	(2010)	(2012)	(2014)	(2016)	(2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs reporting country	0.0334 (0.0556)	0.0688 (0.0672)	0.0524 (0.0447)	-0.225** (0.0782)	0.546*** (0.124)
Customs partner country	1.240*** (0.118)	0.366*** (0.0821)	0.0446 (0.112)	0.387*** (0.0991)	0.790*** (0.157)
Infrastructure reporting country	0.230*** (0.0666)	0.200* (0.0864)	-0.156 (0.105)	0.483** (0.172)	-0.272 (0.226)
Infrastructure partner country	1.145*** (0.125)	-0.209 (0.138)	0.0399 (0.270)	-0.0282 (0.210)	0.810*** (0.161)
International reporting country	0.0380 (0.0777)	0.0175 (0.0664)	0.245* (0.120)	0.143* (0.0629)	0.276* (0.113)
International partner country	-0.136 (0.136)	0.241*** (0.0559)	0.166 (0.118)	-0.0559 (0.0919)	0.556*** (0.112)
Logistics reporting country	0.157* (0.0641)	0.0843 (0.0823)	0.766*** (0.108)	0.406*** (0.0880)	0.482*** (0.144)
Logistics partner country	-0.692*** (0.184)	-0.867** (0.299)	0.345 (0.311)	0.499*** (0.134)	0.825*** (0.164)
Tracking reporting country	0.0623 (0.104)	0.0287 (0.109)	0.127 (0.148)	0.386*** (0.0813)	-0.133 (0.181)
Tracking partner country	0.459* (0.199)	-0.361* (0.157)	0.781*** (0.190)	0.465*** (0.125)	-0.327 (0.188)
Timeliness reporting country	-0.0485 (0.0553)	-0.224* (0.103)	0.319*** (0.0661)	0.244* (0.110)	-0.153 (0.139)
Timeliness partner country	-0.425 (0.254)	-0.000151 (0.118)	0.297*** (0.0822)	0.267*** (0.0788)	0.557*** (0.105)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	4032	4004	4116	4032	2835

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author’s own calculation

Table B2. Estimation results of robustness check model for capital goods (EU28-ROW)

Years	EU28-ROW (2010)	EU28-ROW (2012)	EU28-ROW (2014)	EU28-ROW (2016)	EU28-ROW (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs reporting country	0.309***	0.355***	0.184**	-0.209*	0.949***
	(0.0548)	(0.0686)	(0.0562)	(0.0948)	(0.122)
Customs partner country	0.567	-0.326*	0.436***	0.548***	1.118***
	(0.312)	(0.136)	(0.0802)	(0.126)	(0.189)
Infrastructure reporting country	0.434***	0.572***	0.197	0.234	0.561***
	(0.0758)	(0.0885)	(0.162)	(0.177)	(0.146)
Infrastructure partner country	-0.111	-0.147	0.231	-0.110	1.146***
	(0.319)	(0.200)	(0.289)	(0.265)	(0.193)
International reporting country	0.212*	0.247***	0.182	0.180*	-0.00232
	(0.0881)	(0.0682)	(0.124)	(0.0764)	(0.108)
International partner country	-0.0374	0.428***	0.504**	0.113	0.628***
	(0.155)	(0.0480)	(0.192)	(0.139)	(0.133)
Logistics reporting country	0.393***	0.435***	0.536***	0.530***	0.756***
	(0.0761)	(0.0840)	(0.108)	(0.0956)	(0.139)
Logistics partner country	-0.551**	0.839*	0.723*	0.773***	1.168***
	(0.204)	(0.353)	(0.332)	(0.158)	(0.197)
Tracking reporting country	0.595***	0.405***	0.376**	0.521***	-0.283
	(0.123)	(0.112)	(0.145)	(0.0974)	(0.189)
Tracking partner country	0.0872	0.396***	1.361***	0.600***	1.053***
	(0.291)	(0.0799)	(0.162)	(0.172)	(0.119)
Timeliness reporting country	-0.0301	-0.543***	0.364***	0.156	-0.130
	(0.0638)	(0.111)	(0.0782)	(0.118)	(0.149)
Timeliness partner country	0.657	0.00475	0.558***	0.426***	1.003***
	(0.361)	(0.148)	(0.138)	(0.122)	(0.130)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	4032	4004	4116	4032	2835

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's own calculation

Table B3. Estimation results of robustness check model for consumption goods (EU28-ROW)

Years	EU28-ROW (2010)	EU28-ROW (2012)	EU28-ROW (2014)	EU28-ROW (2016)	EU28-ROW (2018)
Ind./Dep. var.	trade	trade	trade	trade	trade
Customs reporting country	0.0149	0.129	-0.0445	-0.178	0.386***
	(0.0640)	(0.0705)	(0.0597)	(0.0962)	(0.104)
Customs partner country	-0.309	0.289**	0.444***	0.793***	0.657*
	(0.292)	(0.0963)	(0.127)	(0.149)	(0.296)
Infrastructure reporting country	0.279***	0.338***	0.151	0.223	-0.164
	(0.0724)	(0.0815)	(0.121)	(0.185)	(0.157)
Infrastructure partner country	-0.400	0.160	0.799*	-0.195	1.040***
	(0.281)	(0.243)	(0.351)	(0.273)	(0.148)
International	0.115	0.0605	-0.0908	-0.0505	0.279*

reporting country	(0.0717)	(0.0745)	(0.154)	(0.0892)	(0.111)
International partner country	-0.0481	0.671***	-0.0362	0.0353	0.948***
	(0.192)	(0.0863)	(0.105)	(0.127)	(0.127)
Logistics reporting country	0.116	0.158	0.634***	0.231*	0.414**
	(0.0724)	(0.0863)	(0.107)	(0.0990)	(0.148)
Logistics partner country	-0.499*	-0.0255	0.229	1.135***	0.986***
	(0.206)	(0.267)	(0.348)	(0.176)	(0.173)
Tracking reporting country	0.0279	0.0993	0.138	0.0856	-0.391**
	(0.119)	(0.122)	(0.126)	(0.110)	(0.141)
Tracking partner country	0.0722	0.756***	1.343***	1.058***	0.647**
	(0.273)	(0.161)	(0.167)	(0.164)	(0.247)
Timeliness reporting country	-0.0966	-0.320*	0.180*	0.0211	-0.334**
	(0.0664)	(0.151)	(0.0802)	(0.128)	(0.116)
Timeliness partner country	-0.358	0.662***	0.630***	0.474***	0.996***
	(0.339)	(0.198)	(0.0990)	(0.111)	(0.126)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	4032	4004	4116	4032	2835

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's own calculation

Table B4. Estimation results of robustness check model for intermediate goods (EU28-ROW)

Years	EU28-ROW (2010)	EU28-ROW (2012)	EU28-ROW (2014)	EU28-ROW (2016)	EU28-ROW (2018)
Ind./Dep. var.	exports	exports	exports	exports	exports
Customs reporting country	0.291***	0.368***	0.142**	-0.199*	1.029***
	(0.0572)	(0.0587)	(0.0463)	(0.0860)	(0.114)
Customs partner country	0.418	0.00853	0.447***	0.712***	0.971***
	(0.246)	(0.138)	(0.130)	(0.131)	(0.180)
Infrastructure reporting country	0.537***	0.597***	-0.101	0.503**	-0.383
	(0.0770)	(0.0951)	(0.131)	(0.171)	(0.291)
Infrastructure partner country	-0.294	0.431	-0.423	0.0101	0.995***
	(0.290)	(0.305)	(0.242)	(0.280)	(0.185)
International reporting country	0.340***	0.260***	0.391*	0.268**	0.314***
	(0.0817)	(0.0611)	(0.171)	(0.0889)	(0.0875)
International partner country	-0.109	0.538***	0.482***	-0.00391	0.693***
	(0.142)	(0.0738)	(0.0989)	(0.109)	(0.144)
Logistics reporting country	0.540***	0.451***	0.880***	0.701***	1.058***
	(0.0654)	(0.0719)	(0.118)	(0.0809)	(0.114)
Logistics partner country	-0.422	-0.410	0.456	0.977***	0.941***
	(0.231)	(0.291)	(0.408)	(0.162)	(0.182)
Tracking reporting country	0.853***	0.427***	0.159	0.587***	-0.0628
	(0.105)	(0.100)	(0.155)	(0.117)	(0.205)
Tracking partner country	0.413*	0.352***	1.439***	0.572***	0.613**
	(0.200)	(0.105)	(0.163)	(0.121)	(0.238)
Timeliness reporting country	0.000648	-0.316**	0.380***	0.300**	-0.0500
	(0.0647)	(0.102)	(0.0790)	(0.107)	(0.161)

Timeliness partner country	-0.186 (0.157)	0.208 (0.141)	0.292*** (0.0789)	0.406*** (0.0861)	0.729*** (0.169)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	4032	4004	4116	4032	2835

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author’s own calculation

Table B5. Estimation results of robustness check model for capital goods (EU28-ROW)

Years	EU28-ROW (2010)	EU28-ROW (2012)	EU28-ROW (2014)	EU28-ROW (2016)	EU28-ROW (2018)
Ind./Dep. var.	exports	exports	exports	exports	exports
Customs reporting country	0.606*** (0.0668)	0.510*** (0.0991)	0.0619 (0.0480)	-0.321** (0.114)	1.425*** (0.176)
Customs partner country	0.106 (0.291)	0.459*** (0.0477)	0.427*** (0.127)	0.519*** (0.123)	0.668** (0.211)
Infrastructure reporting country	0.771*** (0.0950)	0.875*** (0.127)	0.411* (0.205)	0.0720 (0.147)	0.718*** (0.168)
Infrastructure partner country	-0.552 (0.301)	-0.318 (0.234)	-0.382 (0.309)	-0.245 (0.255)	0.643*** (0.134)
International reporting country	0.509*** (0.0991)	0.344*** (0.0932)	0.223 (0.134)	0.231** (0.0861)	0.0362 (0.115)
International partner country	-0.00824 (0.170)	0.503*** (0.0590)	-0.113 (0.168)	-0.195 (0.120)	0.247 (0.131)
Logistics reporting country	0.789*** (0.0910)	0.625*** (0.121)	0.631*** (0.114)	0.705*** (0.140)	1.096*** (0.212)
Logistics partner country	-0.343 (0.220)	-0.558 (0.609)	-0.0458 (0.330)	0.720*** (0.157)	0.679*** (0.201)
Tracking reporting country	1.207*** (0.147)	0.565*** (0.153)	0.550*** (0.164)	0.625*** (0.112)	-0.244 (0.186)
Tracking partner country	0.184 (0.309)	0.122 (0.105)	0.282 (0.191)	0.109 (0.131)	0.0567 (0.230)
Timeliness reporting country	-0.0211 (0.0767)	-0.651*** (0.160)	0.355*** (0.0909)	0.0538 (0.104)	0.0322 (0.150)
Timeliness partner country	-0.301 (0.211)	-0.0143 (0.162)	0.00210 (0.110)	0.0772 (0.0927)	0.959*** (0.143)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	4032	4004	4116	4032	2835

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author’s own calculation

Table B6. Estimation results of robustness check model for consumption goods (EU28-ROW)

Years	EU28-ROW (2010)	EU28-ROW (2012)	EU28-ROW (2014)	EU28-ROW (2016)	EU28-ROW (2018)
Ind./Dep. var.	exports	exports	exports	exports	exports
Customs reporting country	0.155*	0.0956	-0.134*	-0.287**	0.506**
	(0.0620)	(0.0754)	(0.0654)	(0.110)	(0.155)
Customs partner country	0.0355	-0.977***	1.097***	0.896***	1.509***
	(0.294)	(0.106)	(0.187)	(0.143)	(0.193)
Infrastructure reporting country	0.340***	0.344***	0.338	-0.0669	-0.447
	(0.0919)	(0.102)	(0.188)	(0.187)	(0.232)
Infrastructure partner country	-0.701*	-0.0342	-0.760**	-0.942***	1.546***
	(0.310)	(0.248)	(0.286)	(0.211)	(0.198)
International reporting country	-0.0376	0.0187	-0.0214	0.0203	0.422***
	(0.103)	(0.0778)	(0.141)	(0.0790)	(0.121)
International partner country	-0.0532	0.690***	0.0770	-0.258	0.931***
	(0.205)	(0.120)	(0.0930)	(0.146)	(0.130)
Logistics reporting country	0.167	0.117	0.798***	0.223*	0.464**
	(0.0857)	(0.0924)	(0.108)	(0.110)	(0.158)
Logistics partner country	-0.316	0.0741	0.513	1.248***	1.576***
	(0.221)	(0.243)	(0.384)	(0.171)	(0.201)
Tracking reporting country	0.281*	0.0307	0.248	0.240*	-0.702***
	(0.138)	(0.128)	(0.132)	(0.0959)	(0.147)
Tracking partner country	0.203	0.158	1.453***	0.934***	1.229***
	(0.274)	(0.166)	(0.256)	(0.149)	(0.147)
Timeliness reporting country	-0.0927	-0.443*	0.215*	-0.210	-0.555**
	(0.0719)	(0.177)	(0.0932)	(0.141)	(0.177)
Timeliness partner country	0.0411	0.727***	0.291*	0.577***	1.701***
	(0.341)	(0.201)	(0.121)	(0.119)	(0.147)
Reporter FE	Yes	Yes	Yes	Yes	Yes
Partner FE	Yes	Yes	Yes	Yes	Yes
N	4032	4004	4116	4032	2835

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's own calculation

PROŠIRENI SAŽETAK

Ova se disertacija, kroz tri međusobno povezana i odvojena istraživačka rada, bavi učincima transportne infrastrukture i logističke usluge na međunarodnu trgovinu i gospodarski rast u zemljama srednje i istočne Europe koje su ujedno i članice Europske unije. Općenito se smatra da postoji snažna veza između infrastrukture, trgovine i gospodarskog rasta. To uvjerenje da transportna infrastruktura igra važnu ulogu u gospodarskom rastu i razvoju nije ograničeno samo na političke krugove, već proizlazi iz ekonomske teorije.

Ekonomska analiza transportne infrastrukture seže u ekonomsko promišljanje druge polovice 18. stoljeća (Button 2006.). Primjerice, Adam Smith (1776.) istaknuo je važnost transportne infrastrukture u svojem popularnom radu "Istraga o prirodi i uzrocima bogatstva naroda", ističući da je infrastruktura od javnog interesa, da može smanjiti razvojne nejednakosti između razvijenih i nerazvijenih područja te da bi vlada u nju trebala ulagati. Takvog stajališta su i razne institucije poput Europske komisije, Parlamenta, Svjetske banke, Međunarodnog monetarnog fonda, jer transport i povezana infrastruktura dio su javne politike i predstavljaju javno dobro.

Što se tiče transportne infrastrukture, kejnezijanci su smatrali da kauzalnost ide u suprotnom smjeru, odnosno da gospodarski rast potiče ulaganja u transportnu infrastrukturu, dok neoklasični ekonomisti smatraju infrastrukturu dijelom agregatne proizvodne funkcije. Aschauerov (1989) utjecajni rad je pružio statistički značajne dokaze o utjecaju transportne infrastrukture na gospodarski rast, a kasniji radovi koji su slijedili Aschauerov pristup su došli do sličnih spoznaja (Munnell 1990.; Biehl 1991.; Holtz-Eakin 1992.; Canning 1999.; Cantos, Gumbau-Albert i Maudos 2005.; Calderón, Moral-Benito i Servén 2015.).

Stajalište o pozitivnim učincima transportne infrastrukture na gospodarski rast također je predmet različitih kritika koje smatraju da pristup agregatne proizvodne funkcije nema teorijske i empirijske temelje (Gramlich 1994.; Button 1998.). Jedan je od problema i smjer kauzalnosti, jer postoje dokazi da gospodarski rast uzrokuje potrebu za ulaganjem u infrastrukturu, a ne obratno (Vanhoudt i sur. 2000). Transport omogućuje kretanje u oba smjera, što znači da u nekim slučajevima transportna infrastruktura premješta ljude i izvore u centar, a ne približava periferiju centru, ostavljajući ju u još gorem položaju (Button 2006.). Neki rezultati pokazuju da transportna infrastruktura dugoročno ne promiče rast, već ima kratkoročne učinke (Crescenzi i Rodríguez-Pose

2012.). S druge strane, Pradhan (2019.) potvrđuje pozitivne učinke transportne infrastrukture na dugoročni gospodarski rast u zemljama G-20. Unatoč tim kontradiktornim nalazima, kreatori politike smatraju infrastrukturu pokretačem gospodarskog rasta. Transportna infrastruktura jedan je od stupova rasta i kohezijske politike Europske unije. Kreatori europskih politika smatraju transportnu infrastrukturu instrumentom za smanjenje nejednakosti između starih i novih država članica, tj. između EU-a 15 i država članica srednje i istočne Europe, stvaranjem radnih mjesta, smanjenjem troškova prijevoza, olakšavanjem trgovine, poboljšanjem pristupa resursima itd. Inicijativa EU-a „Transeuropske transportne mreže” dobar je primjer, jer je motivirana političkom kohezijom. Osim toga, međunarodne organizacije poput Svjetske banke također podržavaju ulaganja u transportnu infrastrukturu diljem svijeta, posebice u kontekstu smanjenja nejednakosti između razvijenih zemalja i zemalja u razvoju. Prometni kapaciteti posebno su važni u slučaju malih otvorenih gospodarstava kao što su Republika Hrvatska i većina zemalja središnje i istočne Europe koje su članice Europske unije (CEMS), gdje učinkovit transportni sustav omogućuje povećanje međunarodne trgovine i time potiče gospodarski rast. Udio transporta u bruto domaćem proizvodu razvijenih zemalja iznosi oko 6 – 12 %. Smatra se da u eri globalizacije konkurentna prednost svakog gospodarstva ovisi, između ostalog, o omogućavanju učinkovitijeg prijevoza ljudi i dobara, dok ključnu prepreku može predstavljati nedostatak učinkovite i visokokvalitetne transportne infrastrukture.

Tijekom prijelaznog razdoblja, posebno od početka 1990-ih, nije se dovoljno ulagalo u željezničke pruge i željezničku infrastrukturu u CEMS-ima, što je dovelo do zastarjelosti transportnog sektora i određivanja prioritizacije cestovnog transporta nauštrb željezničkog prometa. U posljednjih nekoliko desetljeća prometni sektor dramatično je porastao u Europskoj uniji (EU-u), a najveći porast zabilježen je u cestovnom transport (Europska komisija 2012. u Bonči, Udovču i Rodeli 2017.). Ulaganja EU-a u transportnu infrastrukturu jedan su od ključnih mehanizama, ako ne i ključni, koji mogu povećati gospodarski razvoj i konvergenciju (Crescenzi and Rodríguez-Pose 2012). Glavni problemi željezničkog sustava većine zemalja CEMS-a uključuju loše stanje infrastrukture i željeznica, probleme koji odražavaju aktivnosti teretnog i putničkog transporta, nedostatak učinkovitih željezničkih veza s morskim i riječnim lukama te nedovoljnu integraciju nacionalne mreže u europsku transportnu mrežu, čime se sprječava provedba interoperabilnosti sustava. Iako su pretpristupna financijska ulaganja EU-a znatno povećala povezivost i dostupnost u tim zemljama, željeznički transport znatno zaostaje (Europski parlament, 2016.).

S obzirom na navedeno, cilj je prvoga istraživačkog rada ove disertacije ponovno razmotriti pitanje utjecaja transportne infrastrukture na gospodarski rast.

U ovome istraživanju korištena je analiza panel podataka za jedanaest država srednje i istočne Europe koje su članice Europske unije (CEMS) u razdoblju 1995. – 2016. godine. Zemlje CEMS-a analizirane u ovom radu su, od sjevera do juga: Estonija, Latvija, Litva, Poljska, Češka, Slovačka, Mađarska, Slovenija, Hrvatska, Rumunjska i Bugarska. Prvotni uzorak uključivao je Maltu i Cipar; međutim, te su zemlje bile izuzete iz procjene jer nemaju uspostavljene željezničke mreže. Zemlje CEMS-a odabrane su iz sljedećih razloga: kao prvo, sve su doživjele tranziciju prema tržišnim gospodarstvima; drugo, primaju značajna financijska sredstva EU-a koja se ulažu u transportnu infrastrukturu jer su to nove države članice EU-a; i treće, postoji praznina u literaturi koja istražuje te zemlje.

Kako bi se postigao cilj istraživanja, primjenjuju se dva ekonomska modela. Prvi ekonomski model uključuje šest varijabli: bruto domaći proizvod, broj stanovnika, ulaganje u infrastrukturu, otvorenost trgovine, infrastrukturu željezničkog prometa i infrastrukturu cestovnog prometa. Bruto domaći proizvod upotrebljava se kao pomoćna varijabla za gospodarski rast. Nezavisne varijable su odabrane na temelju prethodne empirijske literature (Barro i Lee 2013.; Ismail i Mahyideen 2015.; Keho 2017.). Odabir varijabli za transportnu infrastrukturu temelji se na radu Pradhan i Bagchi (2013.); a kao pomoćna varijabla za željezničku infrastrukturu koristi se duljina ukupnih željezničkih pruga, dok se kao pomoćna varijabla za cestovnu transportnu infrastrukturu koristi duljinu ukupne cestovne mreže, pri čemu su obje varijable izražene u kilometrima. Svi su podaci preuzeti iz Eurostatove baze podataka (2017). Kao provjera robusnosti originalnog modela, koristimo se dodatni, drugi model koji se temelji na Aschauerovoj (1989) agregatnoj proizvodnoj funkciji. Varijable realni BDP, broj zaposlenih osoba (u milijunima), prosječni godišnji sati rada zaposlenih osoba i kapital (u milijunima USD, 2017.) dobivene su iz Penn World Tables, verzija 10, dok podaci o transportnoj infrastrukturi, cestovnoj, željezničkoj, zračnoj i lučkoj infrastrukturi dolaze iz Eurostatove baze podataka (2017.). U drugom modelu su uključene i druge vrste transportne infrastrukture, s obzirom da se veliki dio tereta kojim trguju zemlje EU s trećim zemljama prevozi upravo zračnim i morskim putem. U ovom slučaju su uzete i druge mjerne jedinice koje odražavaju iskoristivost infrastrukture, kao što su tonski kilometri. Model uključuje deset zemalja CEMS-a – sve zemlje kao u prvom modelu, osim Latvije koja je izbačena iz procjene zbog malih varijacija.

Standardni pristup u analizi panel podataka (linearni model) uključuje tri različita procjenitelja: združeni (POLS), fiksne učinke (FE) i slučajne učinke (RE). Iako se a priori pretpostavlja da je model fiksnih učinaka najpogodniji za analizu, u radu su prezentirani rezultati analize sa sva tri različita procjenitelja: POLS, koji se primjenjuje samo ako su zemlje homogene (gospodarska i politička struktura koje mogu utjecati na promatrane varijable generiraju opažanja promatranih varijabli, ali se ne mogu izričito mjeriti i sadržane su u pogrešci), FE i RE. Ti su modeli odabrani na temelju prethodnih empirijskih istraživanja primjenom fiksnih i slučajnih efekata za procjenu utjecaja transportne infrastrukture na međunarodnu trgovinu (Ismail i Mahyideen 2015.) i utjecaja vertikalnog odvajanja na učinkovitost sustava željeznica (Laabsch i Sanner 2012.).

Procjenitelj fiksnih učinaka (FE) koristi se pri procjeni učinaka koji variraju tijekom vremena, s obzirom na to da specifičnosti pojedinačnih panel jedinica koreliraju s jednim regresorom ili više njih. Naime, svaka jedinica (zemlja) ima svoje specifičnosti koje se s vremenom ne mijenjaju (npr. geografski položaj, kultura, jezik itd.) i očekuje se da će te karakteristike biti u korelaciji s regresorima, tj. nezavisnim varijablama. Procjenitelj FE uklanja te specifičnosti, što rezultira procjenom samo onih varijabli koje variraju u vremenu. S druge strane, ako pretpostavimo da pojedine specifičnosti ne ovise o regresorima, pogodan je procjenitelj RE. S tehničke strane, Hausmanovim testom odlučujemo koji je procjenitelj prikladniji za podatke koje imamo i, kao što je to obično slučaj u empirijskim istraživanjima, Hausmanov test odbacuje H_0, odnosno da je RE dosljedan i učinkovit kao i FE te da se stoga trebamo držati FE-a. Budući da je analiza rađena s relativno malim uzorkom, prezentirani su rezultati sva tri procjenitelja kako bi se provjerilo jesu li rezultati konzistentni.

Rezultati prvoga modela ukazuju na značajne i pozitivne učinke na gospodarski rast svih promatranih varijabli osim varijable željeznice. Rast stanovništva, investicije i trgovinska otvorenost imaju pozitivne učinke na gospodarski rast, dok u slučaju željezničke infrastrukture sva tri procjenitelja pokazuju značajne ($p < 0,01$) i negativne učinke željezničke infrastrukture na gospodarski rast u promatranom razdoblju za jedanaest zemalja CEMS-a. Željeznička infrastruktura u CEMS-u zastarjela je i neučinkovita, a prema analizi prometa Europskog parlamenta iz 2016., postoje uska grla u povezanosti i vremenu putovanja u željezničkim sustavima

CEMS-a. Podaci pokazuju da su vremena putovanja u starim državama članicama (EU-15) dva do četiri puta kraća nego u CEMS-u. Nadalje, veza sjever-jug kroz tri baltičke države predstavlja željeznički jaz. Luke i njihove željezničke veze sa zaleđem suočavaju se s ograničenjima na oba kraja Baltičko-jadranskog koridora, dok je nekoliko prekograničnih željezničkih uskih grla zabilježeno između većine zemalja CEMS-a i između zemalja CEMS-a i EU-15. Ne iznenađuje da rezultati naše analize u slučaju sva tri procjenitelja bilježe negativan i značajan koeficijent ($p < 0,01$).

Rezultati drugoga modela u skladu su s našim očekivanjima. Rezultati pokazuju da radna snaga (prosječni odrađeni sati) i kapital (po radniku) imaju značajan i pozitivan utjecaj na output. Međutim, u slučaju varijabli koje su od najvećeg interesa, transportne infrastrukture, za razliku od prvog modela, gdje su procjene željezničke infrastrukture bile negativne, procjene u modelu agregatne proizvodne funkcije nisu značajne. Procjene agregatne proizvodne funkcije (Model dva) pokazuju da je samo cestovna infrastruktura značajna za gospodarski rast. Ti rezultati potvrđuju da se ne mogu donijeti precizni zaključci o transportnoj infrastrukturi i da širenje ekstenzivnih resursa za transportnu infrastrukturu nije uvijek opravdano jer količina nije dobra zamjena za kvalitetu. Međutim, također treba imati na umu da su promet i infrastruktura dio javne politike i da predstavljaju javno dobro, te su s tog stajališta ulaganja u infrastrukturu opravdana.

Transportna infrastruktura je javno dobro te se ulaže u infrastrukturu u zemljama CEMS-a kako bi se osigurala kohezija između EU-15 i CEMS-a. Međutim, da bi se potaknuo održiv gospodarski rast u zemljama CEMS-a, uz transportnu infrastrukturu trebalo bi uzeti u obzir i druge popratne čimbenike kao što su gospodarsko okruženje, institucije, ICT tehnologija i logističke usluge koje funkcioniraju usporedo sa samom infrastrukturom. Istraživanje doprinosi prepoznavanju uloge transportnog sustava u nacionalnom i regionalnom gospodarstvu te također ukazuje na potrebu preispitivanja razvojnih politika i strategija CEMS-a na način da se ulaganja u infrastrukturu i razvoj transeuropskih prometnih mreža razmatraju u širem kontekstu koji uključuje druge povezane aktivnosti kao što su logistika i olakšavanje trgovine koje istodobno oblikuju transportnu infrastrukturu i o njoj ovise.

Osim transportne infrastrukture, akademska zajednica i kreatori politika sve se više zanimaju za logističke usluge. Bez transportne infrastrukture i učinkovite logističke usluge, globalna trgovina i kretanja dobara diljem svijeta ne bi bili mogući. Logistika se odnosi na mrežu aktivnosti potrebnih za omogućavanje fizičkog kretanja dobara i prekogranične trgovine. Te aktivnosti nadilaze sam prijevoz i uključuju pretovar, skladištenje, pakiranje, operacije na terminalima te upravljanje podacima i informacijama potrebnim za praćenje otpreme i pravovremenu dostavu (Arvis i sur. 2018.). Sve te aktivnosti odgovorne su za promicanje međunarodne trgovine, a time i gospodarskog rasta.

Svjetska je banka prvi put 2007. g. objavila indeks logističke učinkovitosti (LPI) koji obuhvaća sve navedene mjere olakšavanja trgovine, tj. carinjenje, transportnu infrastrukturu, kvalitetu logističke usluge, pravovremenost i mogućnost praćenja pošiljke. LPI je dobio značajnu pozornost u međunarodnoj trgovinskoj literaturi i diskursu javne politike, a istraživači su ga počeli koristiti kao zamjensku varijablu za olakšavanje trgovine i uključili ga u analizu međunarodne trgovine. Behar i Manners (2008.) ugrađuju LPI 2007 po prvi put u gravitacijski model kako bi istražili učinke logistike zemlje podrijetla i odredišta na bilateralni izvoz i učinke logistike susjednih zemalja na izvoz. Oni koriste agregatni LPI kao pomoćnu varijablu za logistiku zemlje podrijetla i odredišta, a njihovi nalazi pokazuju da logistika pozitivno utječe na izvoz, međutim, logistika zemalja koje međusobno graniče važna je samo za izvoznike koji nemaju izlaz na more.

Hertel i Mirza (2009.) te Felipe i Kumar (2012.) pridonose literaturi uključivanjem LPI indeksa i njegovih podindeksa kao mjere olakšavanja trgovine kako bi se procijenili učinci olakšavanja trgovine na trgovinu u azijskim zemljama koristeći pristup gravitacijskog modela. Dok Hertel i Mirza koriste samo jedan LPI-jev podindeks u svakoj regresiji, Felipe i Kumar u jednu jednadžbu uključuju sve LPI-jeve podindekse. Zaključci obiju analiza su da olakšavanje trgovine pozitivno utječe na trgovinu i da je infrastruktura najvažniji podindeks LPI-ja. Prema procjeni Felipea i Kumara, dobit u trgovini varira od 28 % u slučaju Azerbejdžana do 63 % u slučaju Tadžikistana. Njihovi rezultati također upućuju na to da, s gledišta izvoznika, infrastruktura ima najveći utjecaj na trgovinu, dok s gledišta uvoznika carinska učinkovitost ima najveći učinak na trgovinu. Marti Marti, Puertas i Garcia (2014a, 2014b) procjenjuju učinke logističke učinkovitosti na trgovinske tokove u zemljama u razvoju koje su svrstane u pet regija: Afriku, istočnu Europu, Daleki istok, Južnu Ameriku i Bliski istok. Oni kontroliraju trgovinu između različitih skupina proizvoda u skladu s njihovom logističkom složenošću i njihovi nalazi pokazuju da logistička učinkovitost postaje tim važnija što je teže prevoziti robu. Slično tome, Saslavsky i Shepherd (2014.) istražuju učinke učinkovitosti logistike na trgovinu dijelovima i komponentama unutar međunarodnih proizvodnih mreža, a njihov glavni zaključak je da je trgovina dijelovima i komponentama osjetljivija na učinkovitost logistike nego trgovina gotovim proizvodima. Bresslein i Huber (2016) analiziraju trgovinske obrasce zemalja EU-a, razlikujući trgovinu dijelovima, komponentama i gotovim proizvodima koristeći Eurostatovu bazu podataka COMEXT na osmeroznamenkastoj razini. Njihovi nalazi potvrđuju da se trgovinski obrasci razlikuju za različite vrste proizvoda, tj. dijelove, komponente i gotove proizvode te da su sve zemlje EU-a aktivne kroz sve opskrbne lance, no dok razvijene zemlje trguju uglavnom s drugim razvijenim zemljama, manje razvijene zemlje EU-a trguju s razvijenijim zemljama.

Najnovija istraživanja Ganija (2017.) i Host, Pavlić Skender i Zaninović (2019.) procjenjuju učinke logističke učinkovitosti na međunarodnu trgovinu pomoću podataka za veliki uzorak zemalja te se slažu da logistička učinkovitost ima statistički značajan i pozitivan učinak na trgovinske tokove, posebno na izvoz. Osim toga, Bugarčić, Skvarciany i Stanišić (2020.) analiziraju utjecaj logističke učinkovitosti na opseg trgovine unutar dviju skupina zemalja, zemalja srednje i istočne Europe koje su članice Europske unije i zapadnog Balkana te zaključuju da podindeksi međunarodne pošiljke, logistička kvaliteta i stručnost te praćenje i nalaženje pošiljaka imaju najveći utjecaj na opseg trgovine u promatranoj godini 2018. Naposljetku, iz većine empirijskih studija proizlazi da logistička učinkovitost i olakšavanje trgovine općenito imaju važnu ulogu u međunarodnoj trgovini. Nalazi otkrivaju da su logistika i transport sve važniji za trgovinu među opskrbnim lancima te je stoga potrebno istražiti i bolje razumjeti kako se trgovinski obrasci razlikuju među različitim skupinama zemalja u okviru gospodarske integracije te kako logistička učinkovitost i njezini podindeksi utječu na trgovinu različitim skupinama proizvoda. Sudjelovanje u regionalnim i globalnim lancima opskrbe, posebno za nove zemlje EU-a, značajno je za njihovu konkurentnost i stoga je cilj ove disertacije, između ostalog, otkriti učinke logističke učinkovitosti na EU trgovinu određenim skupinama proizvoda i ponuditi prijedloge za buduće trgovinske i logističke politike. Stoga je cilj drugoga istraživačkog rada ispitati homogenost dvaju blokova zemalja EU-a u smislu učinkovitosti logistike, odnosno ispitati utjecaj logističke učinkovitosti na međunarodnu bilateralnu trgovinu EU-15 i CEMS-a s ostatkom svijeta u razdoblju 2010. – 2018. g.

Novina koju donosi ovaj istraživački rad je da istražuje utjecaj razlike između vrijednosti podindeksa logističke učinkovitosti (u daljnjem tekstu: LPI) između trgovinskih partnera na njihovu bilateralnu trgovinu koja pokriva razdoblje od 2010. do 2018. godine. Istražuje se je li razlika u LPI-ju statistički značajna i utječe li na bilateralnu trgovinu. Ovaj rad proširuje postojeća istraživanja na način da se klasificira robu kojom se trguje prema klasifikaciji gospodarskih djelatnosti (BEC), koju potom agregiramo u tri osnovna razreda dobara u sustavu nacionalnih računa (SNA): intermedijarna, kapitalna i potrošačka dobra. Na taj se način istražuje i potencijalni heterogeni utjecaj razlika u LPI-ju u odnosu na različite klase roba (proizvoda). U ovom području istraživanja je literatura o istraživanjima specifičnih proizvoda ili skupina proizvoda oskudna, a prisutan je i nedostatak empirijskih nalaza o učincima poboljšanja trgovinske logistike na trgovinu specifičnim skupinama proizvoda. Pretpostavka ovog istraživanja je da različite logističke funkcije nisu jednako važne za različite proizvode; npr. kvarljiva priroda prehrambenih proizvoda ili osjetljivost kemijskih proizvoda čini ih ranjivijim na kašnjenja u trgovini (Liu i Yue, 2013.). Stoga se u ovome radu pokušavaju otkriti moguće razlike u trgovini različitim skupinama proizvoda. Za procjenu utjecaja logističkih performansi na međunarodnu trgovinu koristi se strukturni gravitacijski model. Kao pomoćna varijabla za logističku učinkovitost koristi se LPI, odnosno njegovih šest podindeksa, tj. „učinkovitost carinjenja i nadzora granica, kvaliteta trgovinske i transportne infrastrukture, jednostavnost dogovaranja konkurentne cijene pošiljaka, kompetentnost i kvaliteta logističkih usluga, mogućnost praćenja i pronalaženja pošiljaka te, u konačnici, učestalost kojom pošiljke dolaze do primatelja u predviđenom ili očekivanom roku isporuke" (Arvis i sur. 2018.).

Ovaj istraživački rad istražuje kako se trgovinski obrasci razlikuju među različitim skupinama zemalja. U središtu pozornosti u radu su zemlje Europske unije, pri čemu razlikujemo stare članice EU-a (u daljnjem tekstu: EU-15) od novih članica EU-a ili tzv. zemalja srednje i istočne Europe koje su članice Europske unije (u daljnjem tekstu: CEMS). Uspoređuju se učinci razlike u LPI-ju na bilateralnu trgovinu između te dvije skupine zemalja i ostalih svjetskih zemalja (ROW). Istraživanja razlika u logističkoj učinkovitosti unutar ekonomskih integracija i njihovog utjecaja na trgovinske tokove su očito nedostatna. Ovo istraživanje je relevantno za zemlje CEMS-a, koje su poznate po relativno kompliciranom prijelazu s planiranog na tržišno gospodarstvo, zastarjeloj prometnoj infrastrukturi, ali i dobrom geografskom položaju i članstvu u EU-u. Prema izvješću Mordor Intelligence (2018.), CEMS, kao što su Češka, Mađarska, Poljska i Slovačka, nalaze se među zemljama s najbržim rastom u EU-u. Međutim, njihovo je logističko tržište još uvijek u ranoj fazi i nerazvijeno je u usporedbi s logističkim tržištima starih zemalja članica EU-a. CEMS se treba uhvatiti ukoštac s problemom loše infrastrukture, posebice željeznica, političkom korupcijom, nedostatkom konkurentnosti itd. Unatoč aktualnim poteškoćama, zemlje CEMS-a su atraktivne za ulaganja u logistiku. Stoga je s makroekonomskog stajališta važno uzeti u obzir potencijale logističkog tržišta CEMS-a i njegov utjecaj na međunarodnu trgovinu. S druge strane, analizira se EU-15, osnovna skupina zemalja EU-a koja se u osnovi koristi kao referentnu vrijednost za CEMS.

Istraživanje se temelji na teoriji gravitacijskog modela međunarodne trgovine. Od pionirskog rada Tinbergena (1962.), gravitacijski model često se, desetljećima, koristi u brojnim istraživanjima međunarodne trgovine (Anderson i van Wincoop 2004.; Behar i Manners 2008.; Bergstrand 1985., 1989.; Frede i Yetkiner 2017.; Host, Pavlić Skender i Zaninović 2019.; Krugman 1991b; Zajc Kejžar, Kostevc i Zaninović 2016.). U radu se razvija sljedeći strukturni gravitacijski model za procjenu učinaka razlika u logističkoj učinkovitosti između trgovinskih partnera na bilateralnu trgovinu. U drugom istraživačkom radu ove disertacije procjenjuje se utjecaj logističke učinkovitosti na međunarodnu (bilateralnu) trgovinu. Analizirani podaci se sastoje od bilateralnih trgovinskih podataka između zemalja članica EU-28 i njihovih trgovinskih partnera, ukupno 157 zemalja. Unutar zemalja EU-28 razlikuju se dvije skupine: nove članice EU-a, tj. sve zemlje koje su postale članice EU-a od 2004. godine (CEMS) i stare članice EU-a (EU-15). Treća skupina zemalja su treće zemlje koje se zovu „ostatak svijeta“ (ROW). Izvor bilateralnih trgovinskih podataka je UN-ova baza podataka Comtrade (2020). Podatci o BDP-u su preuzeti iz baze podataka Svjetske banke, a podaci za ostale standardne “gravitacijske” varijable su preuzeti iz baze podataka CEPII. Podaci za glavnu varijablu varijablu od interesa, podindekse LPI-ja, dobiveni su od Svjetske banke. Ekonomski model u ovom radu sadrži šest varijabli: bilateralnu trgovinu, veličinu gospodarstva izmjerenu BDP-om, udaljenost trgovinskih partnera, logističku učinkovitost mjerenu u šest područja i standardni skup dummy varijabli koje su obično uključene u gravitacijski model kao što su zajednička granica i postojanje zajedničkog jezika između trgovinskih partnera.

Model se prosjenjuje pomoću Poissonova procjenitelja pseudomaksimalne vjerodostojnosti (PPML), koji su Santos Silva i Tenreyro (2006.) prvi put ugradili u gravitacijski model. Također koriste se “efekti trećih zemalja” (eng. Multilateral resistance terms) koji se uvode preko fiksnih efekata uvoza i izvoza, slijedeći tako jedan od utjecajnih radova u ovom području istraživanja, onaj

Andersona i Van Wincoopa (2004). Na taj se način dobivaju konzistentne procjene varijabli gravitacijskog modela, koje su robusne za različite uzorke heteroskedastičnosti. Nadalje, korištenjem PPML-a mogu se uključiti nulte vrijednosti trgovine, izbjegavajući tako izvor pristranosti. Prema našim podacima, na razini državnih parova opaženo je 5,2 % s nultom vrijednošću trgovine.

Rezultati analize pokazuju da varijacije u podindeksima LPI-ja mogu objasniti varijacije u ukupnoj trgovini, odnosno, što je veća razlika u podindeksima LPI-ja, to je manja trgovina između trgovinskih partnera. Što je još važnije, rezultati ukazuju na to da postoji heterogeni utjecaj podindeksa LPI-ja na trgovinu, što je vidljivo i u poduzorcima EU-15 – ROW i CEMS – ROW te u sve tri skupine proizvoda. Najnegativniji i najznačajniji utjecaj povećanja razlike u LPI-ju između trgovinskih partnera vidljiv je u slučaju trgovine intermedijarnim dobrima između EU-15 i ROW-a. Taj je nalaz u skladu s očekivanjima jer se gotovo dvije trećine globalne trgovine odnosi na intermedijarna dobra, a trgovina intermedijarnim dobrima usko je povezana s regionalnim i globalnim lancima vrijednosti koji oblikuju regionalnu i globalnu trgovinu i globalno gospodarstvo. Zanimljivo je napomenuti i da su podindeksi kao što su pravovremenost dopreme, praćenje pošiljke i konkurentnost cijena usluge, koji su u domeni privatnog sektora, značajniji za trgovinu intermedijarnim dobrima, dok su carina i infrastruktura relevantniji za trgovinu kapitalnim dobrima. Rezultati istraživanja također pokazuju da razlike u LPI-ju između trgovinskih partnera za obje skupine zemalja EU-a jače utječu na trgovinu intermedijarnim dobrima, ali to varira kroz različite godine. Globalna recesija iz 2008. godine imala je negativan učinak na globalnu trgovinu koja je teže pogodila zemlje EU-15, koje su više orijentirane na globalne lance opskrbe u usporedbi sa CEMS-om. Dugoročno gledano, u ovom slučaju, od 2010. do 2018. g., EU-15 je stabilizirao trgovinske tokove s ROW-om, dok je CEMS i dalje u velikoj mjeri okrenut regionalnoj trgovini i regionalnim lancima opskrbe, pri čemu je LPI značajna prepreka u trgovini s ROW-om.

Iz rezultata ovog istraživanja proizlazi nekoliko važnih političkih implikacija. Zemlje CEMS-a trebaju uložiti više napora u razvoj trgovinske logistike kako bi se približile EU-15 u razvoju logističkih usluga jer će se time ukloniti uska grla, osigurati bolji transportni koridori za trgovinu, doprinijeti smanjenju vremena trgovanja i povećati konkurentnost cijena pošiljaka. Logistička učinkovitost je prvenstveno zajednički posao javnog i privatnog sektora, a kako bi se poboljšala logistička učinkovitost, zemlje i integracije moraju istovremeno raditi na promjenama u brojnim područjima, kao što su infrastruktura, postupci na graničnim prijelazima i regulatorno okruženje, regulacija transporta i razvoj privatnog sektora. Razvoj privatnog sektora trebao bi biti jedan od prioriteta za CEMS, s obzirom na to da njegove komponente utječu na trgovinu intermedijarnim dobrima. Na taj način zemlje CEMS-a imat će veće izglede za povećanje sudjelovanja u globalnim lancima opskrbe.

Proces liberalizacije trgovine, smanjenje tradicionalnih carinskih barijera i povećanje broja sporazuma o slobodnoj trgovini pojačali su trgovinu u lancu opskrbe, a sada se više pozornosti posvećuje necarinskim barijerama koje utječu na opseg prekogranične trgovine. Stoga je smanjenje tih trgovinskih barijera i poboljšanje olakšavanja trgovine jedno od najvažnijih pitanja u današnjem globalnom gospodarstvu. Hoekman i Shepherd (2013.) napominju da olakšavanje trgovine ima „različita kontekstualna značenja" jer ne postoji standardna definicija olakšavanja trgovine i različite institucije ga drukčije opisuju. U ovoj disertaciji izraz „olakšavanje trgovine" se koristi za upućivanje na mjere koje se mogu provesti u dva područja: tvrde infrastrukture, koja se odnosi na fizičku infrastrukturu kao što su ceste, željeznice, zračne luke, morske luke te informacijske i komunikacijske tehnologije (ICT), te meke, nefizičke infrastrukture, koja se odnosi na transparentnost, politike, pravila, propise, poslovno okruženje i druge nematerijalne institucionalne aspekte (Portugal-Perez i Wilson 2012.).

Učinkovita fizička infrastruktura i infrastruktura IKT-a, kao i meka infrastruktura na graničnim prijelazima i u institucijama, posebno su važne za mala otvorena gospodarstva, kakva su u većini zemalja CEMS-a, specijalizirana za proizvodnju određenog dijela ili komponente konačnog proizvoda i diversifikaciju njihova izvoza. Veće sudjelovanje u globalnim lancima vrijednosti i uključivanje u trgovinu putem lanca opskrbe omogućuje diversifikaciju izvoza i stjecanje konkurentne prednosti u pristupu većim tržištima, što je ključno za održiv gospodarski rast i razvoj.

Osim efekata učinkovitosti transportne infrastrukture i logistike, učinkovitost na granicama i u institucijama ima ključnu ulogu u olakšavanju međunarodne trgovine, posebice globalnih lanaca vrijednosti. U empirijskoj literaturi koriste se različiti pokazatelji kao mjere olakšavanja trgovine, kao što su pokazatelji lakoće poslovanja Svjetske banke ili pokazatelji logističke učinkovitosti Svjetske banke, no nijedna empirijska analiza ne obuhvaća sve te aspekte olakšavanja trgovine. Nadalje, postoji jaz u literaturi u pogledu učinaka olakšavanja trgovine, posebno trgovine u lancu opskrbe, što čini otprilike dvije trećine današnje trgovine. Složenost trgovanja u opskrbnom lancu zahtijeva adekvatnu fizičku infrastrukturu kao što su ceste, željezničke pruge, luke, telekomunikacijska mreža, koje će omogućiti fizičko kretanje dobara te meku, nefizičku infrastrukturu koja podržava sve procese vezane uz trgovinu i njezinu organizaciju. Trgovina u opskrbnom lancu može biti vrlo korisna za gospodarstvo CEMS-a olakšavanjem ulaska u proizvodnju novih vrsta proizvoda i pružanjem komparativne prednosti u proizvodnji određenih proizvoda. Tvrtke se mogu specijalizirati za određene aktivnosti i zadatke u kojima su konkurentne sudjelovanjem u globalnim lancima vrijednosti. Olakšavanje trgovine utječe na smanjenje fiksnih troškova sudjelovanja u trgovini u opskrbnom lancu, što je velika prepreka internacionalizaciji, osobito za mala poduzeća koja prevladavaju u CEMS-u. Stoga je cilj trećega istraživačkog rada u ovoj disertaciji istražiti, s jedne strane, pitanje mjerenja olakšavanja trgovine uključivanjem različitih pokazatelja koji obuhvaćaju sve aspekte olakšavanja trgovine te, s druge strane, procijeniti učinak olakšavanja trgovine na tradicionalnu trgovinu i pružiti dodatne spoznaje, posebice za trgovinu u opskrbnom lancu.

Analizirani podaci uključuju bilateralne trgovinske podatke između 130 zemalja izvoznica i 130 partnerskih zemalja te pokrivaju razdoblje od 2000. do 2019. godine. Podaci za tradicionalnu trgovinu dolaze iz baze podataka UN Comtrade, dok podaci za trgovinu u opskrbnom lancu dolaze iz baze podataka Eora MRIO. Ostale varijable u modelu kao što su podaci o bruto domaćem proizvodu (BDP-u), podaci o sporazumima o slobodnoj trgovini i podaci o udaljenosti preuzeti su iz baze podataka CEPII. Varijable tvrde i meke infrastrukture (pokazatelji olakšavanja trgovine) dolaze iz Svjetskog gospodarskog foruma (WEF), Izvješća o globalnoj konkurentnosti, Svjetskih pokazatelja upravljanja (WGI) i Poslovne baze podataka Svjetske banke. Izvorni uzorak podataka (tvrda i meka infrastruktura) uključivao je 16 pokazatelja. Međutim, potvrdna faktorska analiza korištena je za izradu četiri agregirana „sintetička" pokazatelja koji predstavljaju varijable tvrde i meke infrastrukture: fizičku infrastruktura, infrastrukturu IKT-a, institucionalnu učinkovitost i učinkovitost na graničnim prijelazima. Uz postojeće varijable, u model je uključena varijabla bilateralna pozicija u lancu opskrbe na temelju metodologije Koopmana i sur. (2010.) koja ima značajan učinak na trgovinu u lancu opskrbe, kao i indeks ekonomske kompleksnosti koji predstvlja tehnološki razvoj zemlje. Teorijski okviri trećega istraživačkog rada u disertaciji također se temelje na teoriji gravitacijskog modela međunarodne trgovine koji je razvio Tinbergen (1962). U radu je razvijen strukturni gravitacijski model koji kao regresore koristi razlike u varijablama trgovinskih partnera. Osim toga, u procjenama se koriste fiksni efekti za izvoznike i uvoznike, kako su predložili Anderson i Van Wincoop (2004.) te Baldwin i Taglioni (2006.), jer se time eliminiraju moguće pristranosti u rezultatima procjene. Za rješavanje problema, između ostalih, nulte vrijednosti i heteroskedastičnosti, korišteni procjenitelj je Poissonov procjenitelj pseudomaksimalne vjerodostojnosti (PPML), koji Santos Silva i Tenreyro (2006.) uvode u postavke gravitacijskog modela.

Rezultati upućuju na to da infrastruktura IKT-a ima još važniju ulogu u trgovini u CEMS-u jer su koeficijenti interakcije vrlo značajni i pozitivni za tradicionalnu trgovinu i trgovinu u opskrbnom lancu. Rezultati upućuju na to da učinkovitost na graničnim prijelazima u interakciji sa CEMS-om ima značajne negativne učinke na tradicionalni izvoz i uvoz te uvoz iz opskrbnog lanca. Rezultati pokazuju da broj dokumenata i dana za uvoz i izvoz ima znatno veći utjecaj na trgovinu u CEMS-u u odnosu na ostale zemlje u našem uzorku. Zemlje CEMS-a općenito su više usredotočene na regionalnu trgovinu, a većina trgovine odvija se unutar Europske unije. Također postoji veća vjerojatnost da će CEMS biti uključen u regionalne, a ne u globalne lance opskrbe. Ta tvrdnja potkrijepljena je s nekoliko empirijskih radova (Elekdag i Muil 2013.; Sobański 2015.; Capello i Perucca 2015.; Damijan i Kostevc 2011.; Kulbacki i Michalczuk 2021.). Nedavni zaključci Zaninović, Zaninović i Pavlić Skender (2021.) pokazuju da su zemlje CEMS-a uglavnom uključene u regionalnu trgovinu, prvenstveno sa zemljama EU-15, a zatim s drugim zemljama CEMS-a. S druge strane, zemlje EU-15 trguju uglavnom s EU-15, a potom sa zemljama CEMS-a, a njihova trgovina s trećim zemljama deset je puta veća od trgovine CEMS-a s trećim zemljama, odnosno izvan EU integracije. Ovi rezultati upućuju na zaključak da su zemlje EU-15 više globalno orijentirane u odnosu na zemlje CEMS-a, koje trguju uglavnom sa zemljama unutar integracije. S političke perspektive, rezultati ovoga rada trebali bi doprinijeti razumijevanju potencijalnih dobitaka u tradicionalnoj trgovini i trgovini kroz lanac opskrbe poboljšanjem određenih elemenata olakšavanja trgovine. Rezultati prikazani u ovome radu trebali bi potaknuti raspravu između tvoraca politika i dionika o određivanju temeljnih prioriteta u njihovim nastojanjima da olakšaju trgovinu.

Ograničenja istraživanja su u tome što su podaci analizirani u sva tri istraživanja na agregatnoj, makroekonomskoj razini. Bolji uvid u stvarni utjecaj transportne infrastrukture i logističke učinkovitosti bio bi moguć kada bi imali podatke na razini poduzeća koji bi omogućili da se uzme u obzir više heterogenosti među entitetima u panelu. Osim toga, u prvome istraživanju korištene su zamjenske varijable za transportnu infrastrukturu, koje su već utvrđene u literaturi, ali kvantiteta transportne infrastrukture ne može zamijeniti kvalitetu. Istraživanje bi se moglo obogatiti korištenjem varijabli kao što su broj prevezenih putnika ili prevezena dobra po kilometru cesta i željeznica. Podaci o logističkoj učinkovitosti korišteni u drugom istraživačkom radu odnose se na kratko razdoblje i sadrže informacije za svake dvije godine. U budućnosti bi dulje razdoblje omogućilo da se umjesto analiza vremenskog presjeka izvrše procjene panel podataka. U trećem istraživačkom radu pokazatelji olakšavanja trgovine izrađeni su na temelju dostupnih sekundarnih podataka. Međutim, olakšavanje trgovine može se analizirati u užem ili širem smislu; postoji širok raspon pokazatelja dostupnih istraživaču koji bi se mogli iskoristiti za orijentaciju budućih istraživanja na konstrukciju različitih pokazatelja olakšavanja trgovine koji uključuju druge aspekte olakšavanja trgovine koji nisu obuhvaćeni ovom disertacijom.

Ova disertacija doprinosi postojećem znanju na više načina. Postoji nedostatak empirijske literature o utjecaju transportne infrastrukture na gospodarski rast u zemljama središnje i istočne Europske unije. Stoga ova disertacija objedinjuje i testira postojeću literaturu o transportnoj infrastrukturi i gospodarskom rastu. Rezultati ove disertacije pridonose boljem razumijevanju uloge transportne infrastrukture u europskom gospodarstvu i podržavaju politike EU-a usmjerene na izgradnju i revitalizaciju transportne infrastrukture u zemljama srednje i istočne Europe.

Ova disertacija također pridonosi teoriji međunarodne trgovine iz perspektive logistike. Koliko je poznato u postojećoj literaturi, ovo je prvi put da se empirijski istražuju razlike u logističkoj učinkovitosti između trgovinskih partnera u trgovini različitim skupinama proizvoda, posebno za trgovinu EU-15 i CEMS-a zemalja. Osim teorijskog doprinosa, ovi rezultati su važni i za praktičnu primjenu. Rezultati istraživanja pružaju tvorcima politika i poduzećima važne informacije o čimbenicima koji im mogu pomoći u promicanju njihove trgovine, integraciji u opskrbne lance i diversifikaciji izvoza. Znanje o tome koji element logistike ima najveći utjecaj na trgovinu u određenoj skupini proizvoda daje važan doprinos kreiranju trgovinske politike na nacionalnoj razini i razini poduzeća. Naposljetku, glavni doprinos ove disertacije je utvrđivanje specifične komponente olakšavanja trgovine, tvrde i meke infrastrukture, koja je najvažnija za promicanje tradicionalne trgovine i trgovine u opskrbnom lancu.

U sadašnjoj empirijskoj literaturi koristi se ili logistička učinkovitost ili pokazatelji tvrde i meke infrastrukture za analizu njihova utjecaja na trgovinu. Međutim, u ovoj se disertaciji prvi put provodi analiza iz obje perspektive, tj. logističke učinkovitosti i drugih mjera olakšavanja trgovine. Ovo je ujedno i prvi put da se suprotstavljaju učinci olakšavanja trgovine na tradicionalnu trgovinu i lanac opskrbe. U ovoj se disertaciji analizira trgovina u opskrbnom lancu kroz prizmu trgovine dodanom vrijednošću, a ne tradicionalne bruto trgovine, što je također prvo takvo istraživanje i doprinos postojećoj empirijskoj literaturi. Nalazi disertacije doprinose razumijevanju potencijalnih dobitaka u tradicionalnoj trgovini i trgovini u opskrbnom lancu poboljšanjem određenih elemenata olakšavanja trgovine. Nalazi predstavljeni u ovoj disertaciji pružaju potporu i smjernice tvorcima politika i dionicima u privatnom sektoru, posebno u zemljama CEMS-a, o tome kojim elementima olakšavanja trgovine treba dati prednost kako bi se osigurala učinkovita trgovina te, posljedično, gospodarski rast.

CURICCULUM VITAE

Petra Adelajda Zaninović was born on 10 August 1989 in Rijeka. She graduated from high school Gimnazija Eugena Kumičića in Opatija. After that, she enrolled at the Faculty of Economics and Business in Rijeka and finished her Bachelor's degree and Master Degree. In 2016, she started her postgraduate doctoral studies in Economics and Business Economics at the Faculty of Economics and Business in Rijeka. During her doctoral studies, she also continued her education at the University of Vienna, Faculty of Business, Economics and Statistics, and at the University of Ljubljana, School of Economics and Business.

Currently, she is a teaching assistant at the Faculty of Economics and Business in Rijeka. She also worked as a cruise specialist in cruise department at Katarina Line and as a project administrator at the EU-funded project European Social Fund, implemented by the Faculty of Economics and Business in Rijeka.

Her research interests are in the field of international logistics, trade facilitation, supply chains and global value chains. She is happily married and has a two year old daughter.

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The undersigned Petra Adelajda Zaninović, a student at the University of Rijeka, Faculty of Economics and Business (hereafter: EFRI), author of this doctoral dissertation with the title The Effects of Transport Infrastructure and Logistics Services on International Trade and Economic Growth: the Case of Central and Eastern European Member States (CEMS), prepared under supervision of assoc. prof. Helga Pavlić Skender, PhD and co-supervision of prof. Katja Zajc Kejžar, PhD.

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Petra Adelajda Zaninović