AN ASSESSMENT OF THE IMPACT OF LOGISTICS AND RELATED INFRASTRUCTURE ON THE ECONOMY: A COMPARATIVE ANALYSIS OF THE VISEGRAD COUNTRIES

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Abstract: On a global scale, effective logistics and the management thereof are critical for sustainable economic growth. Logistics are seen as the support sector of the economy that 'oils the wheels' for growth. The objective of the study was to analyse the impact of the logistics sector and related infrastructure on economic activities. The focus of the study was on the four Visegrad countries and a quantitative research methodology was followed. A three-phased data analysis approach was followed. Firstly, a descriptive comparative data analysis was completed; secondly, a comparative logistics index was constructed; and lastly, secondary panel time series data were used to determine the relationships between variables using Granger causality tests. In terms of results, Poland had the highest economic logistics index, followed by the Czech Republic, Slovakia and lastly, Hungary. From the literature review and data analysis, well-developed, managed and maintained logistic infrastructure could significantly enhance economic growth. Development policies should be directed to such strategies. The scientific contribution of the research is the formulation of the comparative logistics index.

Keywords: Comparative analysis, economic growth, infrastructure, logistics, Visegrad countries

Introduction

Globally, the logistics industry has developed at a rapid pace, supporting economic growth in production and trade (Sezer & Abasiz, 2017). Estimates indicate that the logistics industry is worth between US$8 and US$12 trillion or 12% of global GDP on an annual basis. The trucking component is dominant with 43% of costs allocated to this component, while storage contributes 33%, and other non-trucking transport accounts for only 14% (Maiden, 2020). Logistic management and logistic-related infrastructure have been labelled as a critical enabler of economic progress and growth (Mangan & Lalwani, 2016; Oláh et al., 2018a; Oláh et al., 2018b; Meyer & Meyer, 2019). According to Rietveld and Bruinsma (2012), economic activities such as production and movement of products only occur as a result of effective logistics, infrastructure and integrated modes of transport. According to Szymonik (2013), the logistics and transport systems allow for

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economic activities to happen and oil the wheels of the economy. In this process sustainable development principles should also be taken into account through effective supply chains and the circular economy (Dhonde & Patel, 2020). According to Petriková and Trebuňa, (2017), effective logistics also leads to improved and accelerated competitive advantage in terms of possible cost reduction in supply, inventory reduction and improvement of range and quality of products for customers. According to Skorobogatova and Kuzmina-Merlino (2017), research regarding the various interrelated components of logistics, infrastructure and transport and the relationship with the economy is important.

The problem being investigated in this study is to analyse the extent of the impact of logistics components on the economy. The study region selected is the four Visegrad countries, which are the Czech Republic, Hungary, Poland and Slovakia. These countries form a homogenous region with similar economic characteristics and cultures with interrelated logistics and transport systems. Research questions to be addressed include: What are the impacts of logistics and related logistics infrastructure on economic growth in the Visegrad countries? and What are the differences between the various Visegrad countries regarding logistics? According to Sezer and Abasiz (2017), globalisation has forced countries to increase their logistic capacities to remain competitive, and logistics networks are the most important elements of the modern economy (Shpak et al. 2018), linking partners from both developed and developing countries (Sroka, 2015). The significance and contribution of the study relate to the assessment and linkage between logistics management and economic activities and the comparative analysis between the Visegrad four. Limited comparative research studies have been conducted regarding this relationship as well as on the selected countries, and this research attempts to contribute to cover this gap in the literature.

Literature review

This section of the research is divided in three sub-sections: (1) definitions of important concepts; (2) theoretical foundation; and (3) some empirical results from similar previous studies. Logistics are defined by Christopher (2017) as "the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders". Logistics have to do with aspects including planning and control of flows of material between suppliers and consumers. Continuous upgrades and improvements in logistics and transportation are critical contributions to production, consumption and overall economic activities. Logistics are a leading sector in economic growth and development (Kuzu & Önder, 2014).

Sezer and Abasiz (2017) describe logistics as a process of flow of information starting from a point of origin with raw material to an end point of a final product

to be consumed, as well as planning and controlling of this process of flow from a storage and inventory facilities point of view. Logistics services include the following types: insurance, transport, clearance at customs, handling, storage, packaging, inventory management, and management of customer relations. According to Havenga (2010), the costs for logistics are divided into the following main elements: (1) transport cost, (2) port and storage handling costs, and (3) administration and management costs.

According to Gudehus and Kotzab (2012), logistics could be divided into two main categories similar to economics with macro-economics and micro-economics. In the case of logistics, in macro-logistics mean the use of logistics for effective and efficient supply to consumers, firms and government with flows of goods and products within regions, countries and across the globe. In order to achieve economic development and growth, quality institutions and policy are requirements in collaboration with efficient logistic infrastructure (Sadaf, Oláh, Popp, & Máté, 2018). In addition, micro-logistics have the aim to supply individual firms and consumers with the required mobility demand for goods and services in an effective manner through service providers, planning, systems and networks (Oláh, Sadaf, Máté, & Popp, 2019).

Wood et al. (2012) state that logistics is an umbrella term for many concepts to explain a system that controls the flow and storage of materials, parts and finished products. Logistic functions include: consumer service, demand forecasting, systematic flow of goods, inter-plant movements, inventory management, order processing, warehouse selection, production scheduling, traffic management, and distribution management.

In addition to logistics management, logistic infrastructure is also an important concept to understand. Within this context, the quality and availability of logistics infrastructure are vital relating to the existence and the effective spatial distribution of intermodal facilities, the density and number of logistics firms are important in enhancing international competitiveness (Bensassi et al., 2015). Gleissner and Femerling (2013) state that logistic infrastructure serves as the "backbone of logistics systems" and in addition to basic transport infrastructure, supports infrastructure including logistics centres/distribution centres and their spatial locations as well as the telecommunication infrastructure are important for logistics.

In addition, Catalbas (2012) states that as a result of the intertwined relationship between economics and logistics, the concept of "economics of logistics" was established. Economics of logistics is a process where logistic firms follow the economic principles of attempting to maximise their returns and profits with the lowest cost possible, providing in the unlimited needs of clients and customers. Maximum profits with low input costs are only possible via good management and include factors such as productivity, labour cost, economic growth, and the contribution of the logistics industry to the economy. Kramar et al. (2015) analysed

the relative importance of logistics in achieving competitive advantage in an increasing integrated and globalised economy. The researchers tested the correlation between the World Bank Logistics performance index and the WEF Global Competitiveness Index and the results indicate a positive relationship.

Logistics are increasingly included as a determinant of economic growth and development (Sánchez et al., 2012; Coto-Millán et al., 2013). In both studies, the results confirmed the positive relationship between logistics and economic performance (Sánchez et al., 2014). The critical contribution of efficient freight logistics infrastructure to economic growth is also confirmed by Arvis et al. (2008), and Rodrigues et al. (2005). A number of empirical results on this research topic have been analysed and are listed in this section. Sezer and Abasiz, (2017) analysed the impact of the logistics industry on economic growth in the OECD countries. Logistics are an important industry, which provides income, employment, and foreign direct investment. Regarding the micro-scale, the logistics industry is an important industry in improvement of competitiveness of firms. The industry also plays a role in the improvement of the competitiveness of other industries and most economic sectors are dependent on the logistics sector. The results of the study found that both transportation industry variables and communication industry variables that form the logistics industry had a positive impact on per capita income in OECD countries. Hayaloglu (2015) investigated the impact of improvements in the logistics sector on economic growth in 32 OECD countries from 1994 to 2011 using panel data. An effective logistic sector facilitates increases in international trade, competitiveness and is therefore a factor and determinant of economic growth and development. The results revealed a positive relationship between developments in the logistic sector and economic growth, but the significance of the impacts differs depending on the indicator used to represent the logistics sector. D'Aleo and Sergi (2017) assessed the impact of logistics on economic growth in the Euro zone. Findings from the study indicate a positive relationship between the Global Competitiveness Index (GCI), logistics performance and GDP.

Chu (2012) analysed the relationship between investment in logistics and economic growth in 30 provinces in China from 1998 to 2007 using panel data model. The results from the analysis indicate a positive and significant impact of investment in logistics on regional economies in China. The findings also confirmed that the role and impact of logistics investment are significantly greater for under developed interior provinces than for more developed coastal provinces. Lean et al. (2014) also assessed the relationship between logistics performance and economic development in China. The results from the causality tests confirm that economic growth does cause increased logistics output, indicating that economic growth causes increased demand for logistics services and therefore results in increased logistics development. More detailed results indicated that rail transport unidirectionally causes more development for both road and water transport.

Munim and Schramm (2018) investigated the impact of quality of ports, seaborne trade, logistics management and performance in 91 countries with seaports on economic performance. The study compared developing countries with developed countries across the globe. The results are interesting and confirm that quality port infrastructure leads to improved logistics performance, resulting in increasing seaborne trade, and eventually allowing for economic growth in developing countries, but the impact is less significant in more developed countries.

Hausman et al. (2013) assessed the impact of logistics performance on global bilateral trade. In this study, the performance in logistics refers to total impact on timeframes, costing and overall complexity of logistics services in facilitating import and export activities. The results confirmed the positive impact of effective logistics performance on economic growth and the reduction in costs, time and complexity contributes to increased competitiveness of countries regarding logistics, trade and the economy in general.

Liu (2016) analysed the logistics sector in Thailand and found low levels of efficiency, which are evident from the relatively high logistics costs in relation to GDP. It was found that high logistics costs have a negative impact on the sustainable development of the economy. The government has attempted to implement appropriate logistics policies to improve the logistics system and costs in the country. Sezer and Çavuşoğlu (2018) state that since the 1980s the logistics sector has grown rapidly as a service industry and contributed to increased national and international economic growth. He tested the causal relationship between the logistics sector and economic growth for the BRICS countries and Turkey from 1993 to 2017. The results indicate that no causal relationships exist between the variables airline freight transportation and economic growth for all of the countries involved. In summary regarding the empirical results, logistics as an economic sector are critical for most economic activities as a service industry. Logistics are vital for economic growth, international trade, competitiveness, employment and investment.

Data and methodological approach

The paper has a quantitative research methodology with descriptive and time series components. The descriptive data analysis was used more intensively due to a number of variables with limited time series observations. In this process, a range of variables were included in the descriptive analysis assessing trends and growth rates. In a second part of the descriptive analysis, a logistics index was compiled in order to compare the four Visegrad countries regarding logistics performance. For the time series analysis, the period of analysis selected is from 2000 to 2018 due to availability of data. A pooled panel analysis was estimated, which included all four the Visegrad countries.

The use of panel data represents datasets over a time series of several years for multiple observation units in this case, the Visegrad four countries. The Visegrad

region was selected as the specific region of focus as these countries form a geographical homogeneous region. In achieving the objectives of the study, two econometric tests were used in the assessment of interactions between variables, namely stationarity tests via panel unit root tests and causality tests using Granger causality tests. The study assesses the relationship between different variables using data from the World Bank Development Indicators (2020) and WEF (2020) datasets. In the process of achievement of one of the objectives of the study, namely the impact of logistics on economic growth, and logistics on export volumes, Granger causality tests were performed. The variables used in the time series model are explained in Table 1. All variables were transformed to natural logarithm value to simplify the analysis and results.

Table 1. Explanation of variables used in the econometrics tests

Variable (acronym used in econometric models)	Definition
GDP (constant 2010 US$) (**GDP** and in logarithm format **LGDP**)	GDP is the aggregate of the total gross value added by all participants in the economy.
Port infrastructure Index (**PortInf** and in logarithm format **LPortInf**)	This variable forms part of the WEF competitiveness index. Ports are evaluated and based on effectiveness of a port, a value is allocated between 1 and 7.
Customs processes Index (**Customs** and in logarithm format **LCustoms**)	This variable forms part of the WEF competitiveness index. Customs processes are evaluated and based on effectiveness of the process, a value is allocated between 1 and 7.
Export volumes Index (**ExpVol** and in logarithm format **LExpVol**)	Export volume indexes are the ratio of the export value indexes to the corresponding unit value indexes.
Export value Index (**ExpVal** and in logarithm format **LExpVal**)	Export values are the current value of exports converted to US dollars and expressed as a percentage of the average for the base period (2000).
Effective Government Index (**EffGov** and in logarithm format **LEffGov**)	This variable forms part of the World Bank Governance Indicators. The effectiveness of governments are evaluated and based of effectiveness of a government with values between -2.5 and +2.5.

Source: World Bank, (2020) and WEF (2020)

Empirical findings and discussion

In this section, the four Visegrad countries are compared in Table 2 using a selection of important variables including some of the variables used in the econometric analysis, but also additional variables not included in the econometric analysis with two years selected to determine any trends, 2010 and 2018. In terms of GDP, Poland has the largest economy and contributes 54.7% of the total

Visegrad economy, followed by the Czech Republic, which contributes 21.5%. Poland also achieved the highest annual growth rate since 2010 of 3.9% per annum. In terms of export volumes index and export value index, Slovakia had the highest volumes index followed by Poland, while Poland also had the highest annual growth rates since 2010; and Poland also had the highest value index with the highest annual growth rates, followed by Slovakia. Czech Republic had the highest effective governance index followed by Slovakia. Both Hungary and Slovakia had declining indexes regarding governance since 2010. All of the four countries had negative growth rates concerning FDI inflows with the Czech Republic receiving by far the highest inflows.

In terms of quality of port infrastructure, Poland had the highest index and was the only country that has improved its port infrastructure index since 2010, while Hungary had the best customs process index with the highest improvement rate followed by Czech Republic. When looking at the global connectiveness index, the Czech Republic had the highest index and therefore best global connectivity followed by Hungary, but Poland had the highest rate of improvement since 2010. Regarding investment in infrastructure, Hungary had the highest % of investment to GDP as well as the highest annual growth rates since 2010; followed by Slovakia while Poland and Czech Republic had negative growth rates. In terms of land freight transport (tonne per km), Poland contributed 73.3% of the total Visegrad land freight with an annual growth rate of 7.4% since 2010. The Czech Republic had the highest value regarding infrastructure maintenance spending with the highest annual growth rate of 6.2%; while Poland had a -7.3% annual growth rate since 2010.

Table 2. Descriptive comparative analysis (annual growth rates listed in % in brackets)

Countries	Czech Republic		Hungary		Poland		Slovakia	
Variables/year	2010	2018	2010	2018	2010	2018	2010	2018
GDP (at constant prices in US$ billions)	208	248 (2.4)	131	161 (2.9)	**479**	**632 (3.9)**	89	113 (3.4)
Export volumes index (relative to 2000 base year)	247	349 (5.2)	226	291 (3.6)	276	437 (7.3)	**324**	**465** (5.4)
Export value index (relative to 2000 base year)	457	694 (6.5)	339	446 (3.9)	503	**820 (7.9)**	**547**	796 (5.7)
Effective governance Index (values between +2 & -2)	**0.91**	**0.92** (0.1)	0.67	0.49 (-3.4)	0.64	0.66 **(0.4)**	0.84	0.71 (-1.9)

FDI inflows ($ millions)	10167	8493 (-2.1)	-2093	-7282 (-30.9)	1840	1203 (-4.3)	2117	2551 (-2.6)
Port infra index	**4.6**	3.5 (-7.9)	4.1	3.2 (-2.7)	3.3	**4.2 (3.4)**	3.9	2.9 (-3.2)
Customs process index	**4.6**	4.9 (0.8)	4.3	**5.2 (2.6)**	4.3	4.6 (0.9)	4.4	4.5 (0.3)
Global connectiveness Index	68	**75 (1.3)**	**75**	70 (-0.8)	59	67 **(1.7)**	60	63 (0.6)
Infra investment (% of GDP)	1.49	0.86 (-5.3)	1.12	**1.93 (9.1)**	**1.99**	0.63 (-8.5)	0.91	1.17 (3.6)
Land freight transport (billion tonne/km)	68	60 (-1.5)	51	58 (1.7)	**288**	**459 (7.4)**	37	45 (2.7)
Total infra maintenance (Euro millions)	1042	**1556 (6.2)**	774	1038 (4.3)	**2853**	1183 (-7.3)	192	312 (7.8)

Sources: World Bank (2020) and OECD (2020)

Table 3 is an additional analysis of the raw descriptive data from Table 2. The data were converted into an index where the highest value per year and per variable was allocated a score of 1.0, a maximum index score per variable. The other raw data were then divided by the highest value and index score were allocated between 0 and 1. All of the index scores per country for the two years were added to determine which of the four Visegrad countries had the highest logistics index. The final raw scores were converted to an index out of 100 allocating equal scores to all variables. The table provides for interesting results in this comparative index. The highest index was achieved by Poland with an index in 2018 of 78.8 followed by the Czech Republic, then Slovakia and Hungary with the lowest index. Of all four the countries, only the Czech Republic was able to improve its index, but only slightly; all three the other countries had a decline in their logistic index. The Czech Republic substantially improved regarding spending on maintenance of infrastructure while moving backwards in investment on infrastructure. Hungary improved most in infrastructure investment and declined in terms of FDI inflows. Poland improved most on its port infrastructure index and declined most regarding overall infrastructure investment. Slovakia improved most regarding infrastructure investment while moved backward in terms of the effective governance index. When a focus is placed on the last two variables, all of the countries improved regarding spending on infrastructure maintenance except for Poland, which had a much lower spending on infrastructure since 2010; and also regarding investment in infrastructure, it was only the two smaller countries, namely Hungary and Slovakia, which had higher levels of investment than in 2010.

Table 3. Comparative logistics development index

Countries	Czech Republic		Hungary		Poland		Slovakia	
Variables / Year	2010	2018	2010	2018	2010	2018	2010	2018
GDP (at constant prices in US$ billions)	0,43	0,39	0,27	0,25	**1,00**	**1,00**	0,19	0,18
Export volumes index (relative to 2000 base year)	0,76	0,75	0,70	0,63	0,85	0,94	**1,00**	**1,00**
Export value index (relative to 2000 base year)	0,84	0,85	0,62	0,54	0,92	**1,00**	**1,00**	0,97
Effective Governance Index (values between +2 & -2)	**1,00**	**1,00**	0,74	0,53	0,71	0,72	0,92	0,77
FDI inflows ($ millions)	**1,00**	**1,00**	-0,21	-0,72	0,18	0,14	0,21	0,30
Port infra index	**1,00**	0,83	0,89	0,76	0,72	**1,00**	0,85	0,69
Customs process index	**1,00**	0,94	0,93	**1,00**	0,93	0,88	0,96	0,87
Global Connectiveness Index	0,91	**1,00**	**1,00**	0,93	0,79	0,89	0,80	0,84
Infra investment (% of GDP)	0,75	0,45	0,56	**1,00**	**1,00**	0,33	0,46	0,61
Land freight transport (billion tonne/km)	0,24	0,13	0,18	0,13	**1,00**	**1,00**	0,13	0,10
Total infra maintenance (Euro millions)	0,37	**1,00**	0,27	0,67	**1,00**	0,76	0,07	0,20
Total index score between 0 and 100 (ranking in brackets)	75.4 (2)	75.8 (2)	54.1 (4)	52.1 (4)	82.7 (1)	78.8 (1)	59.8 (3)	59.3 (3)

Sources: World Bank (2020) and OECD (2020)

In terms of the panel time series analysis, the process commenced via unit roots tests. In order to determine the level of stationarity, unit root tests for the panel data for all the variables were conducted. These tests are necessary to make a decision on which causality estimation model should be used to determine causality between the selected variables. Table 4 reports the results from the unit root tests. The unit root tests are conducted using the Levin, Lin and Chu t*, Im, Pesaran and

Shin W-stat, and the ADF-Fisher chi-square tests (Kot and Raijani, 2020). If all variables have the same level of stationarity, the Granger causality test could be used to determine the direction of causality. The results signify that all variables are stationary at first difference.

Table 4. Unit root and stationarity results

Variables	Levels			First difference		
	Levin, Lin & Chu t	Im, Pesaran and Shin W-stat	ADF - Fisher Chi-square	Levin, Lin & Chu t	Im, Pesaran and Shin W-stat	ADF - Fisher chi-square
LGDP	0.3122	0.9709	0.9905	0.0001*	0.0022*	0.0042*
LPortInf	0.0607	0.8456	0.6015	0.0005*	0.0070*	0.0074*
LCustoms	0.0034*	0.3630	0.1760	0.0004*	0.0059*	0.0045*
LExpVol	0.1653	0.7923	0.9425	0.0023*	0.0002*	0.0018*
LExpVal	0.0110*	0.5774	0.7146	0.0001*	0.0019*	0.0007*
LEffGov	0.3065	0.6174	0.5269	0.0146*	0.0021*	0.0043*

Note: * denotes stationary variable at 5 % significant level of p-values.

The causation between variables is assessed via the Granger causality test, which is a pair-wise analysis. The results in Table 5 suggest a series of unidirectional causality between the variables included in the analysis. It should be noted that the focus on the causality analysis was on LGDP and LExpVol, which were used as dependent variables. The results indicate that export volumes do cause changes in LGDP; LEffGov (effective governance) is an important factor in the logistics and economic environment as it Granger causes movements in LGDP and LExpVol, similar results were reported by Gudehus and Kotzab (2012). LExpVal and LCustoms also cause changes in LExpVol. Lastly, the analysis found a bi-directional causality between LPortInf and LGDP. Similar results were estimated by Lean et al. (2014) and Munim and Schramm (2018). In summary, and in other words, export volumes, effective governance and port infrastructure are predictors of short-term behaviour of GDP in this study for the four Visegrad countries; and export value, effective governance and customs processes are all predicators of export volumes.

Table 5. Pair-wise Granger causality tests

Null hypothesis:	Obs	F-Statistic	Prob.
LExpVol does not Granger cause LGDP	64	4.36557	**0.0078***
LGDP does not Granger cause LExpVol		0.74566	0.5293
LExpVal does not Granger cause LGDP	84	1.04312	0.3784
LGDP does not Granger cause LExpVal		0.20371	0.8935
LEffGov does not Granger cause LGDP	84	3.85865	**0.0125***
LGDP does not Granger cause LEffGov		0.48928	0.6907
LPortInf does not Granger cause LGDP	36	2.37207	**0.0908****
LGDP does not Granger cause LPortInf		3.55484	**0.0264***
LCustoms does not Granger cause LGDP	36	0.96323	0.4233
LGDP does not Granger cause LCustoms		0.17851	0.9101
LExpVal does not Granger cause LExpVol	64	1.66327	**0.0304***
LExpVol does not Granger cause LExpVal		1.14643	0.3382
LEffGov does not Granger cause LExpVol	64	3.44891	**0.0224***
LExpVol does not Granger cause LEffGov		0.51988	0.6703
LPortInf does not Granger cause LExpVol	36	1.72313	**0.0842****
LExpVol does not Granger cause LPortInf		1.30927	0.2903
LCustoms does not Granger cause LExpVol	36	3.78392	**0.0209***
LExpVol does not Granger cause LCustoms		0.30444	0.8219
LEffGov does not Granger cause LExpVal	84	3.00191	**0.0356***
LExpVal does not Granger cause LEffGov		0.22520	0.8786

Note: * and ** denote rejection of null hypothesis at 5 percent level and 10 percent level, respectively.

Conclusions

Logistics are a leading economic sector and its importance has been increasing as globalisation continues. The sector is critical for global economic growth and most other sectors are dependent on effective logistics. National economies are dependent on effective logistics management to be competitive. The overall objective of the study was to assess the impact of the logistics industry and related freight infrastructure on economic activities in the Visegrad countries. A comparative analysis was conducted and a comparative logistics development index was compiled for the four Visegrad countries to assess progress. The main

findings from the analysis are that Poland as the largest economy in the Visegrad region with a GDP contribution of 54.7%, also dominates the logistics industry. Surprisingly, Slovakia had the highest export volumes index, followed by Poland. In terms of export value index and land freight transport, Poland again dominates. Poland also had the highest port infrastructure index, while Hungary had the best customs processing index. The country that is spending most on infrastructure relative to GDP is Hungary, while Poland and Czech Republic have experienced a decline in investment on infrastructure. In terms of maintenance of infrastructure, the Czech Republic is the highest spender followed by Poland but Poland's spending on maintenance has declined significantly since 2010. In terms of the comparative logistics index, Poland had the highest ranking with an index of 78.8 in 2018, although the index declined from 82.7 in 2010. The Czech Republic had the second highest index of 75.8. Final results of the panel time series analysis, using Granger causality tests, found that export volumes, effective governance and port infrastructure do in fact cause increases in economic activity and growth. The significance of the study lies in the fact that the logistics sector was linked to the economy and the status of logistics in the Visegrad countries and impact on the economies was analysed.

A limitation of the study was the availability of extended time series data, but suitable variables were sourced and used in the analysis. Future studies will focus on econometric analysis using long-run and short-run methods such as ARDL and Johansen cointegration estimations to determine the value and significance of coefficients of a selection of economic and logistics variables. The regional focus will be on the Visegrad countries, but also comparisons with other developed and developing regions. The scientific contribution of the research is the formulation of the comparative logistics index. In conclusion, the following policy guidelines for improvement and effectiveness of the logistics industry management are proposed: (1) An effective logistics management system is required for economic growth as it is a critical support and service industry; (2) continuous maintenance and investment in logistics infrastructure are required to stay competitive and to ensure low costs, limited time wastage with modal and spatial integration; and lastly (3) effective governance management and systems are required.

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OCENA WPŁYWU LOGISTYKI I POWIĄZANEJ INFRASTRUKTURY NA GOSPODARKĘ: ANALIZA PORÓWNAWCZA KRAJÓW WYSZEHRADZKICH

Streszczenie: W skali globalnej efektywna logistyka i zarządzanie nią ma kluczowe znaczenie dla zrównoważonego wzrostu gospodarczego. Logistyka jest postrzegana jako sektor wsparcia gospodarki, który „oliwa koła" dla wzrostu. Celem badania była analiza wpływu sektora logistyki i związanej z nią infrastruktury na działalność gospodarczą. W badaniu skoncentrowano się na czterech krajach wyszehradzkich i zastosowano metodologię badań ilościowych. Zastosowano trójfazową analizę danych. Po pierwsze, zakończono opisową analizę porównawczą danych; po drugie, skonstruowano porównawczy indeks logistyczny; i wreszcie, dane szeregów czasowych panelu wtórnego wykorzystano do określenia związków między zmiennymi za pomocą testów przyczynowości Grangera. Pod względem wyników najwyższy wskaźnik logistyki gospodarczej miała Polska, za nią plasowały się Czechy, Słowacja i wreszcie Węgry. Z przeglądu literatury i analizy danych wynika, że dobrze rozwinięta, zarządzana i utrzymywana infrastruktura logistyczna może znacznie zwiększyć wzrost gospodarczy. Polityka rozwojowa powinna być ukierunkowana na takie strategie. Wkład naukowy badań polega na sformułowaniu porównawczego wskaźnika logistycznego.

Słowa kluczowe: analiza porównawcza, wzrost gospodarczy, infrastruktura, logistyka, kraje wyszehradzkie

物流及相关基础设施对经济的影响评估：对一个远景国家的比较分析

摘要：在全球范围内，有效的物流及其管理对于可持续的经济增长至关重要。物流被视为经济的支撑部门，为增长提供"动力"。该研究的目的是分析物流部门和相关基础设施对经济活动的影响。研究的重点是维谢格拉德的四个国家，并采用了定量研究方法。遵循了三阶段的数据分析方法。首先，完成了描述性比较数据分析；其次，建立了比较物流指标。最后，使用格兰杰因果关系检验，使用辅助面板时间序列数据来确定变量之间的关系。从结果来看，波兰的经济物流指数最高，其次是捷克共和国，斯洛伐克，最后是匈牙利。通过文献综述和数据分析，完善，管理和维护良好的物流基础设施可以大大促进经济增长。发展政策应针对此类战略。研究的科学贡献是比较物流指标的制定。

关键字：比较分析，经济增长，基础设施，物流，维谢格拉德国家