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ASSESSMENT OF THE TRANSPORT INTENSITY OF THE EUROPEAN ECONOMY

Summary. The excessive increase in transport intensity is one of the negative impacts on the economy. The costs borne due to transport activities are indirectly expressed by the volume of carriages (in tons) and by the scope of transport activity (in ton-kilometers). The result of social and economic activities are global product values and national incomes. This article shows the research on transport activity expressed through transport activity (in ton-kilometers) for all means of transport in total, the results of social and economic activities expressed using the gross domestic product, as well as shaping transport intensity of national economies in selected European countries. The analysis of the course of the exponential function curves, as well as polynomial curves has been carried out, and conclusions have been formulated on their bases.

Keywords: transport intensity, European economy, GDP, transport activity

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1. INTRODUCTION

The importance of the transport sector in the world economy (to varying degrees) has been repeatedly discussed in the works of M. Mindur³. Transport covers the area of operations, where there is a mutual relationship between the economy and its requirements and its - not always positive - impact on the environment. Nonetheless, it is the transport that sets the directions for the development of infrastructure (ibid, pp. 70-134), and so to some extent, the entire economy. Already in the 70s of the twentieth century, environmental pollution has become an obstacle in European countries to their further development (it was then most perceptible in the Ruhr region of Germany). Since that time, the part of the most environmentally damaging production has been moved abroad, and in other cases, environmentally friendly solutions have been applied, for example, filters on smokestacks and wastewater treatment plants. In Europe, the devastation of the environment resulting from industrial activity has been largely limited, but that has not solved this issue definitively. Pollution caused, inter alia, by transport is so great that it has become a worldwide problem. Its effect is global warming, resulting in melting ice in the zone of the Arctic and Antarctic, and vast areas in Africa undergo emaciation, which results in enlarging the famine zone. It cannot be stated that transport plays the dominant role in this damage; however, denying its part would be false as well. This does not change the fact that the smog produced by vehicles today endangers the further development of some agglomerations (an example of this is the city of Delhi in India or Poland - one of the most polluted European countries). It is not without significance for the development of transport that also a build-up of traffic on the roads and increased number of its participants. Consequently, despite the much smaller technical achievements at the beginning of the twentieth century, travel in urban areas (for example, from the outskirts of London to the city center) would take as much time as it does currently or was even shorter⁴.

2. RELATIONSHIPS BETWEEN THE ECONOMY AND TRANSPORT

The size of transport work in the world (taking as the basis for assessing the growth of transportation in the United States, Russia and China and continuing at an even level, with a downward trend from 2009 to 2015, Japan?), as well as the global economy, tends to increase. This confirms the close relationship between the economy and transportation. Transport is an important production department of any economy, an important factor in technological progress and economy and an essential tool of production.

Securing adequate transportation to meet the needs of the capacity of an economy requires an efficient subsystem cargo. This subsystem should be systematically improved using modern technology, transport and handling, telematics and information technology, management

³ M. Mindur, *Transport in the era of globalization of the economy*, ITE-PIB, Warsaw 2010, *Transport in the economy*, p. 47-99 (in:) *Conditions for the development of the Polish transport system*, B. Liberadzki and L. Mindur (eds.), ITE-PIB, Warsaw 2006, *Trends in shaping transport and transport intensity in the European Union and Poland* (in:) *Liberalization and deregulation of transport in the European Union*, B. Liberadzki (ed.), SGH ILiM, Warsaw 2007, p. 115-134, *Efficient transport as a factor increasing the competitiveness of the national economy* (in:) *Efficient Transport - Competitive Economy*, M. Michałowska (ed.), Publishing house of the University of Economics in Katowice, Katowice 2009, p. 37-40, M. Mindur, *Assessment of the transport intensity of the world economy in 1998–2010* (in:) *Scientific Journals of the University of Gdansk no 46, Modeling of logistics processes and systems, part XII*, Publishing House of the University of Gdansk, Gdansk 2013

⁴ Ibidem, p. 167

methods, etc. Logistics centers and the use of logistics solutions are of great importance in the process of realizing cargo transshipment.

The most important factor (in the efficient use of transport economy), is to adapt the transport activities to the structure and the characteristics of the economy and the nature of its production. For example, the modern system of the US economy and the need to protect its transportation needs means that transport in the United States is considered the most modern, environmentally and human friendly. In general, the transport of the USA railway transport plays a dominant role, that is, the most environmentally friendly one. As studies have shown, American transport has the highest share of intermodal transport and the massive use of containers. In contrast, the development of Russia's economy - based mainly on mining and export of raw materials fuels – resulted because in the rapidly growing transport, pipeline transport has become of paramount importance. China's economic growth, based mainly on the export of manufactured goods, had a strong influence on the development of maritime transport in containers. This is confirmed by the fact that among the fifteen largest container ports in the world, as many as eight (including four with the largest container transshipment) are Chinese ports. In China, along with road transport, inland water transport dominates in land transport. This result from favorable natural conditions, as well as from the development and improvement of the water network by the Chinese government coupled with the financial support of the World Bank⁵.

Transport is involved in all areas of the economy. Transport issues are, for example, an element of economic policy, spatial development policy, social policy, local government policy, as well as budget and fiscal policy. This confirms the thesis about the inextricable relationships and dependencies of the economy and transport⁶.

Phenomena negatively affecting the economy, among other things, includes an excessive increase in transport intensity, which should be subject to rationalizing and limiting measures⁷.

3. METHODS OF STUDYING TRANSPORT INTENSITY

Transport intensity of the national economy is the sum of materials, energy, and labor intensity. Transport intensity consists of the consumption of materials, energy, and labor in the transport business. Generally, transport intensity is defined as a state of engagement of transport activities, resulting from taking up other activities, both economic and social. The state of engagement of transport should be understood as the state of engagement of human and objectified labor in transport operations for all sectors of the national economy, including support for the individual needs of the population in the existing organizing society⁸.

Transport intensity of the national economy can be formulated as the ratio of inputs on transport activities to the effects achieved in the areas of social and economic activity supported by the transport. Production nature of transport shifts the production of transport for goods moved, adding it to the value of those assets. Therefore, the increase in transport intensity results in increase in the unit value of goods shipped, and the increase of total unit cost of production, resulting in price rise.

⁵ The World Bank, available at: <https://www.worldbank.org/en/news/press-release/2018/05/18/china-to-improve-inland-waterway-transport-with-world-bank-support>

⁶ M. Mindur, *Mutual relations and dependencies between the development of the economy and transport*, ITE-PIB, Warsaw 2004, p. 150 et seq

⁷ W. Rydzkowski, K. Wojewódzka-Król, *Transport*, PWN, Warsaw 2010, p. 14 et seq

⁸ *Ibidem*, p. 3-4.

The study on transport intensity of the national economy has the following indicators, inter alia, that can be used:

- tons of freight related to the unit value of global product and national income,
- ton-kilometers of transport work related to the unit value of global product and national income,
- the value of transport and other services core business of transportation related to the unit value of global product and national income⁹.

These measures are in the numerator, while overall spending on transport is in the denominator - the sum effect units utility socio-economic activity. Expenditures incurred for the transport activities are expressed indirectly by the amount of traffic (in tons) and by the volume of transport work (in kilometers). The effect of socio-economic activities is values of global product and national income¹⁰.

4. TRANSPORT INTENSITY ANALYSIS BASED ON EXPONENTIAL CURVES AND SIXTH-DEGREE POLYNOMIAL

In this research, the effects of socio-economic activity were expressed by the value of the gross domestic product in euro (Figure 1), and transport activity by the amount of transport performance (in tkm) in total for all modes of transport (Figure 2). The value of the variable for 2018 was extrapolated using the polynomial trend line of the 6th degree. This extrapolation was made in Microsoft Excel, using one unit ahead trendline forecasting. The values of this extrapolation were calculated using the LINEST function, where after selecting the x variables and y constants, the result is the value of the extrapolated trend line (6th degree polynomial). Figure 3 shows the exponential function curve, while Figure 4 shows a non-linear polynomial curve demonstrating the transport intensity of the national economies of European countries over time.

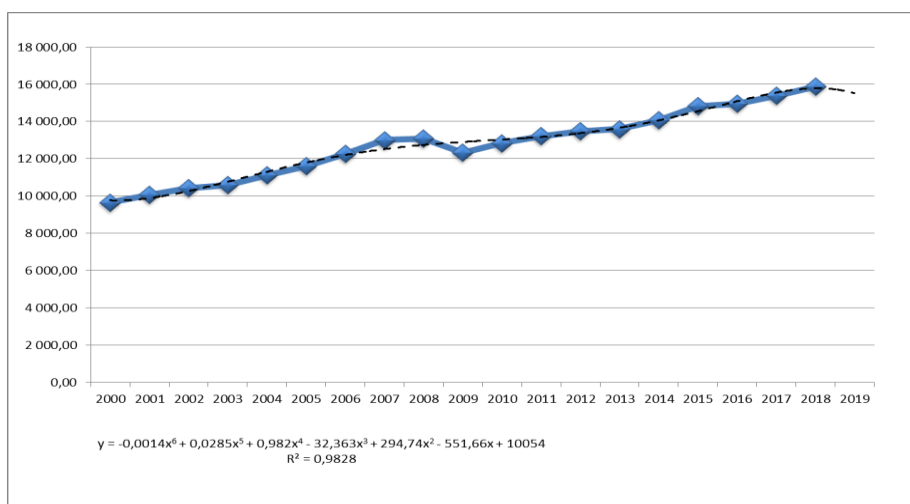


Fig. 1. Evolution of GDP of European countries at market prices (in billion euro)

Source: Authors' study based on [1, 8]ⁱ

⁹ R. Kuziemkowski, *Transport intensity of the national economy*, WKL, Warsaw 1981, p. 60

¹⁰ W. Rydzkowski, K. Wojewódzka-Król, *Transport*, op. cit., p. 5

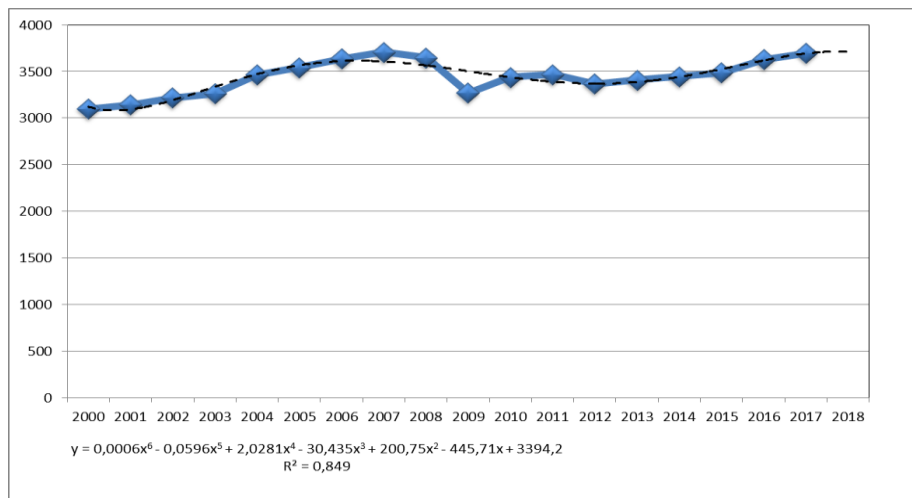


Fig. 2. Evolution of total cargo transport in European countries (in billion tkm)
Source: Authors' study based on [1, 8]ⁱⁱ

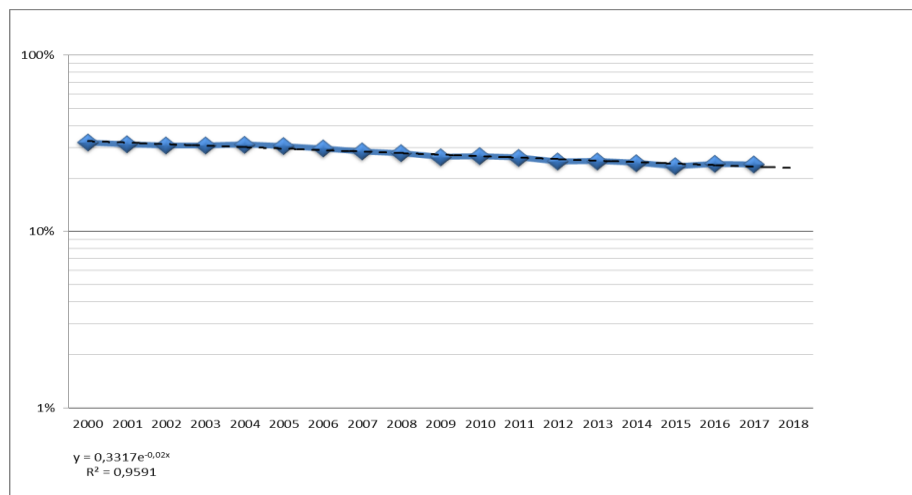


Fig. 3. Transport intensity of national economies of European countries (in logarithmic scale)
Source: Authors' study based on [1, 8]ⁱⁱⁱ

Both the analysis of the curve with exponential functions and polynomial curves allow drawing the following conclusions:

- in European countries, transport intensity in the years 2000–2005 is at a similar level, while from 2006 to 2018 there is a decrease in transport intensity;
- the coefficients of agreement R^2 of the study based on both the exponential function curve and the polynomial curve are relatively high and amount to 0.9591 and 0.9894, respectively.

In the years 2000–2018, the European economy experienced a dynamic GDP growth, except in year 2009, where it dropped to a level comparable to 2006. The decline resulted from the global economic crisis initiated in September 2008 in the US with the collapse of the Lehman Brothers investment bank.

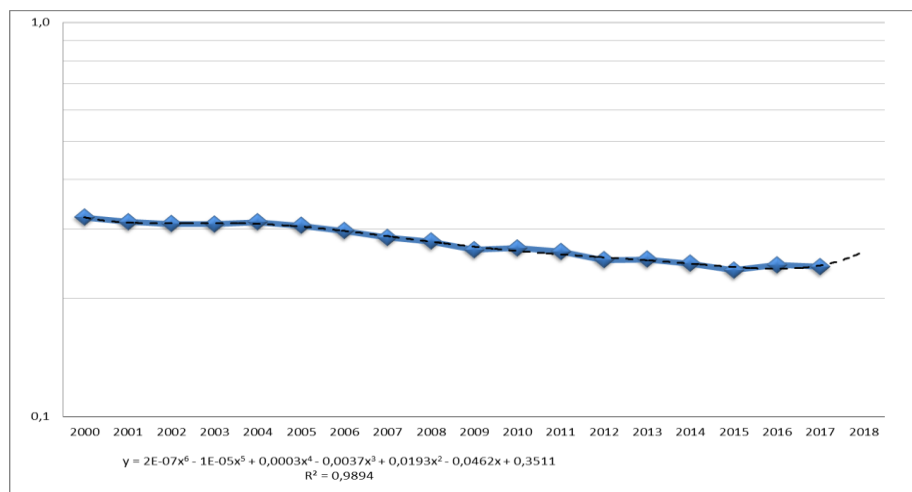


Fig. 4. Transport intensity of national economies of European countries (in logarithmic scale)
Source: Authors' study based on [1, 8]^{iv}

In the analyzed period, there was a dynamic increase in total cargo transport; however, 2009 was characterized by a significant decrease to the level comparable to 2003.

Transport intensity in the analyzed period shows a downward trend. This may mean that the growth of the European economy requires less involvement of transport due to the progressive changes in the structure of the global economy, consisting of the increasing participation of the service sector and the introduction of new technologies.¹¹

The decrease in transport intensity in European countries may be caused by the following factors¹²:

- rationalization of production activities (for example, in terms of reducing transport);
- change in the structure of the economy (growth of the service sector, improvement of the logistics system in the economy consisting in the transition from production "for the warehouse" to the so-called "smooth" economy, which is based on the fact that the last phase of production is the beginning of the process of logistics and transport);
- increasing the efficiency of the transport system expressing, inter alia, a fundamental change in the expectations of transport users (recipients) regarding the quality of its services primarily in the area of full-service transportation and logistics, timeliness of delivery, size of the consignment, delivery at the precise time, money and flexibility to adapt to changing needs. These new expectations should adjust to the service provider (transport company, logistics, forwarding, etc.).

5. SUMMARY

Decline in transport intensity in Europe should be assessed positively, as this will result in lower costs of production and services. The credibility of the shaping of the regression on the charts of both GDP and transport is very high, as it amounts to 0.9828 and 0.849, respectively. The reliability of the course of the GDP curves determined by R^2 is almost close to one. Equally

¹¹ M. Mindur, *Transport in the era of globalization...*, op. cit., p. 42-69

¹² B. Liberadzki, L. Mindur (ed.), *Conditions for the development of the Polish transport system*, ITE-PIB Warsaw 2006, p.14 et seq

high is the credibility of the freight curve close to one, although slightly lower in relation to GDP. The study of the credibility of the transport intensity curves developed based on the 6th degree polynomial gave a very high result of 0.9894 - close to one. On the other hand, R^2 for the graph of the curve developed based on the exponential function for transport intensity is much lower and amounts to 0.9591. Therefore, in this case, it is slightly lower.

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ⁱ M. Mindur, Transport in the age of economy globalization, ITE-PIB, Warsaw 2010, chapter 7, European Statistical Office Eurostat GDP and main aggregates – selected international annual, available at:

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ⁱⁱ M. Mindur, Transport in the age of economy globalization, ITE-PIB, Warsaw 2010, chapter 7, Organization for Economic Co-operation and Development (OECD) Statistics, available at: <https://stats.oecd.org/#>, European Statistical Office Eurostat, available at:

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^{iv} M. Mindur, Transport in the age of economy globalization, ITE-PIB, Warsaw 2010, chapter 7, Organization for Economic Co-operation and Development (OECD) Statistics, available at: <https://stats.oecd.org/#>, European Statistical Office Eurostat, available at:

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