Transport Intensity of the Global Economy in 1995-2015

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Transport covers the area where mutual relations between economy and its requirements take place, and where it affects – not always in a positive way – its surrounding. Simultaneously, it is the transport that marks the direction for the infrastructure development, and hence for the whole economy. The close association between the economy and transport is confirmed by the amount of carriages in the world. The excessive increase of the transport intensity is one of the phenomena that negatively affect the economy. Expenditures incurred for the transport activities are expressed indirectly by the amount of traffic (in tonnes) and by the volume of transport performance (in tonne-km). In contrast, the effect of socio-economic activities are values of global product and national income. The article studied the transport activity in terms of volume of transport work (in tkm) total for all modes of transport, the effects of economic and social activity expressed by means of the value of gross domestic product, as well as the development of the transport intensity of national economies for the selected countries (regions) and for Poland. Analysed were both the curve with exponential functions and polynomial curves, and on their basis conclusions were drawn.

Keywords: transport intensity, global economy, GDP, transport activity passengers.

1. INTRODUCTION

The importance of the transport sector in the world economy (to varying degrees) has been repeatedly discussed in the works of the author (Mindur M., 2010). 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. At the same time 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 became an obstacle in European countries to their further development (then it was most felt it in the Ruhr region in 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, e.g. 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, among others, by transport is in fact so great that it is now a worldwide problem. Its effect is global warming, resulting in the 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 that 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 may be Beijing, where reduction of traffic is being announced). 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 can be observed. As a result - despite a much smaller technical achievements – at the beginning of the twentieth century travel in urban areas (e.g. from the outskirts of London to the city centre) would take as much time as it does currently, or was even shorter (ibid, p. 167).

The involvement of transport takes place in all areas of the economy. The issue of transport has become an element of economic policy, spatial

policy, social policy, politics, local government and local politics, as well as the budgetary and fiscal ones. This confirms the thesis of the inseparable ties and relationships of the economy and transport (Mindur M., 2004, p. 50 and further).

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 – Fig. 2 and continuing at an even level, with a downward trend since 2009 to 2015, Japan) – as well as the global economy – tend 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 economic and an essential tool of production. Securing adequate to meet the needs of the economy capacity requires an efficient subsystem cargo. This subsystem should be systematically improved through the use of modern technology, transport and handling, telematics and information technology, management methods etc. Logistics centres and the use of logistics solutions are of great importance in the process of realizing transhipment of cargo. The most important (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, e.g. a modern system of the US economy and the need to protect its transportation needs meant that transport in the United States is considered the most modern, environmentally and human friendly.

In general transport of the USA, railway transport plays a dominant role for, i.e. 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 the export of raw materials fuels –resulted in the fact that 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 six (including three with the largest container transhipment) are the Chinese ones. In the land transport in China, inland waterway transport dominates which results from favourable natural conditions, as well as from development and improvement of the water network by the government of that country (ibid, p. 235).

2. THE RESEARCH ON TRANSPORT INTENSITY BASED ON EXPONENTIAL CURVES AND POLYNOMIAL CURVES

Phenomena negatively affecting the economy, among other things, include excessive increase in transport intensity, which should be subject to rationalizing and limiting measures (Rydzkowski W., Wojewódzka-Król K., 2002, p. 14 onwards).

Transport intensity of the national economy (Kuziemkowski R., 1981; Koźlak A.; 2007, p. 67; Tomanek R., 2004, p. 31; WojewódzkaKrólK., Rydzkowski W., 2005, p. 6) is the sum of materials, energy and labour intensity. Transport intensity consists of the consumption of materials, energy and labour 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 labour in transport operations for all sectors of national economy, including support for the individual needs of the population in the existing organizing society.

Generally speaking, 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 is to shift the production of transport for goods moved and adding it to the value of those assets. Therefore, the increase in transport intensity results in increase in unit value of goods shipped, and also the increase of total unit cost of production, and that results in price rise.

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

- tons of freight related to the unit value of global product and national income,
- tonne-kilometres of transport work related to the unit value of global product and national income (see. Fig. 1)
- the value of transport and other services core business of transportation related to the unit value of global product and national income (Kuziemkowski R., 1981, p. 60).

These measures are in the numerator overall spending on transport, 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 tonnes) and by the volume of transport work (in kilometres). The effect of socio-economic activities are values of global product and national income (Wojewódzka-Król K., Rydzkowski W., 2005, p. 14).

The research presented in this paper (prepared on the basis of Mindur M., 2010) included transport countries characterized by the highest level of development – being the biggest economies for several decades, forming the bulk of the world's GDP and demarcating the development trends of the modern world, namely the United States of America, Japan and European Union (EU-28). Admission to the analysis of the EU-28 aimed to examine the extent to which the economic and political relationship is consistent, and in which the band independently, autonomously functioning transport systems. It also included two countries with great potential, the greatest area of significant natural resources and military– Russia, and rapidly developing in recent years China (the most populous country in the world, subject to transformations continuously for 30 years and according to some reports having greater participation in the creation of global GDP than Japan). The article also presented Poland, whose economy (by volume) cannot be compared with any of the economies of the countries discussed, and so the analysis of the economic situation is not brought to a comparison of macroeconomic, but shaping economic processes.

In this study the transport activity was expressed by the size of the transport work (in tkm) in total for all modes of transport, and the effects of socio-economic value by gross domestic product in US dollars (for the tested country– See Fig. 2).

For all charts variable for 2015 was extrapolated using a polynomial trend line of the 6th degree. These extrapolations are performed in Microsoft Excel by using the prediction trend line by one unit forward. The value of the extrapolation were calculated using TREND, where after selecting variables x and constants y, the final result is the value of extrapolated trend line (6 degree polynomial).

Figure 3 shows the curves of exponential functions, whereas fig. 4 - Non-linear polynomial curves depicting the evolution of transport intensity of national economies in time for the selected countries (regions) and Poland.

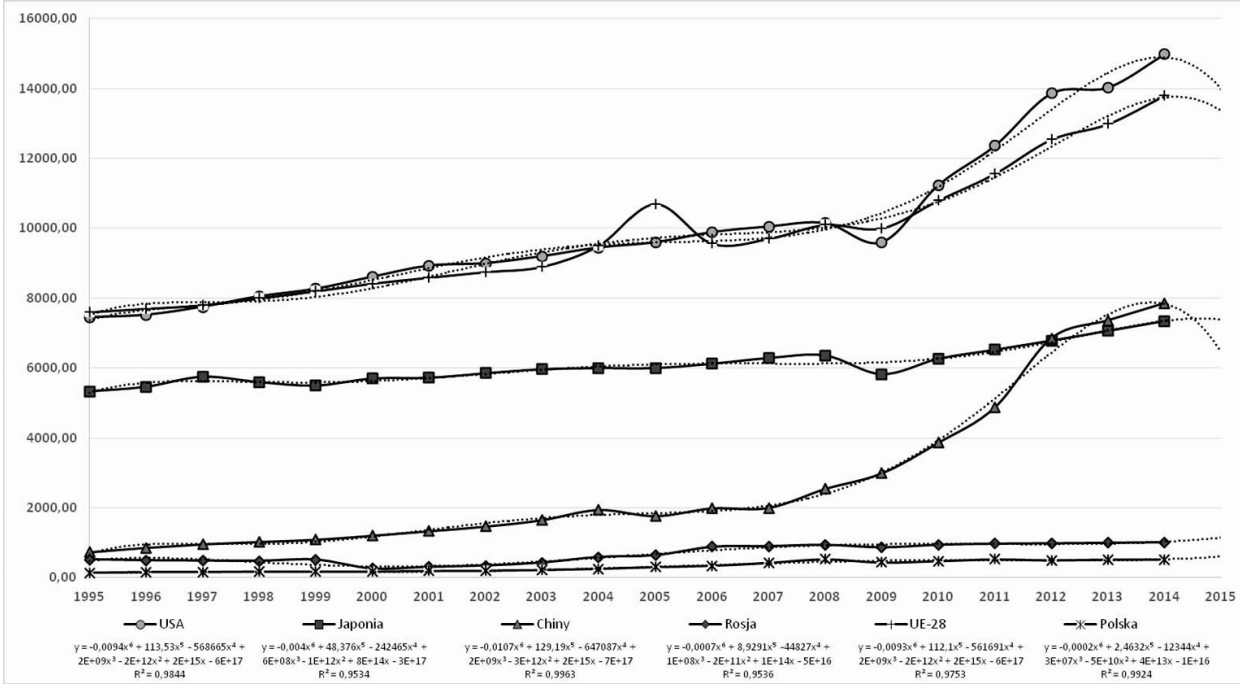

Fig. 1. Development of the GDP of selected economies of the world, in constant prices USD (source: own study based on Mindur M., 2010, Chapter 7; *Statistical Yearbook...; Figures in Europe...; Japan Statistical Yearbook...; China Statistical Yearbook...; Russia in Figures*...).

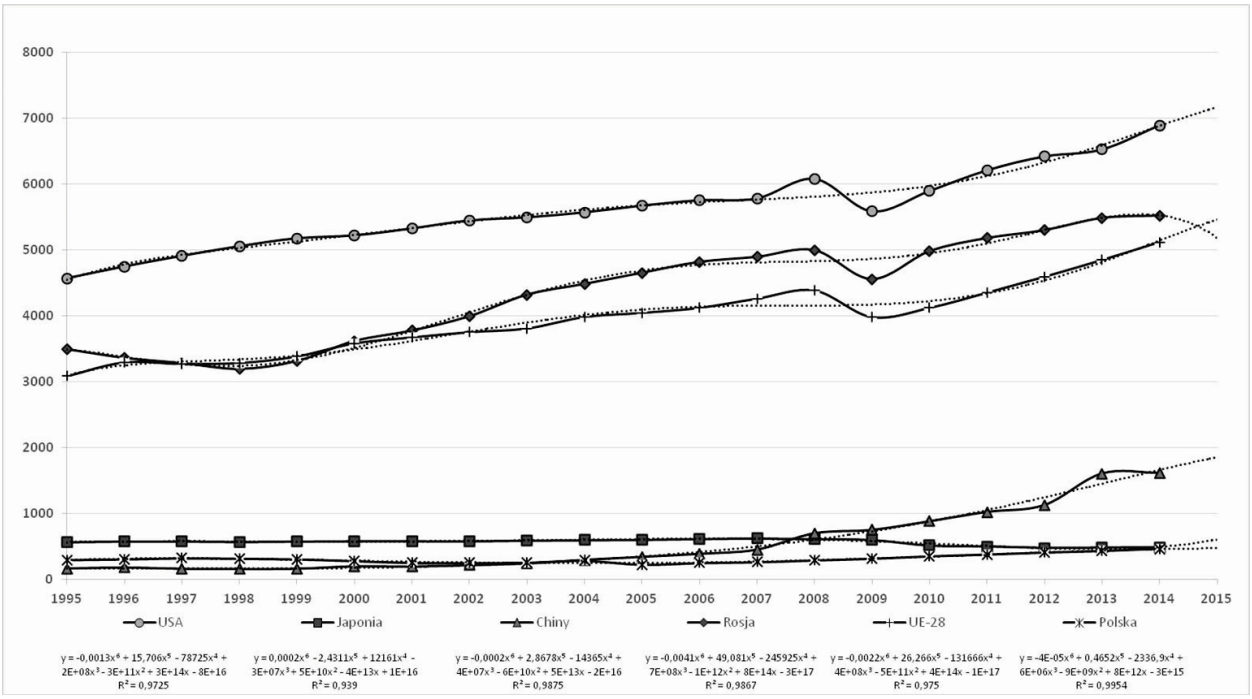

Fig. 2. Evolution of total goods transport of selected countries in billion tonne-kilometres (source: own study based on Mindur M., 2010 Chapter 7; *Statistical Yearbook...; Figures in Europe...; Japan Statistical Yearbook...; China Statistical Yearbook…; Russia in Figures…).*

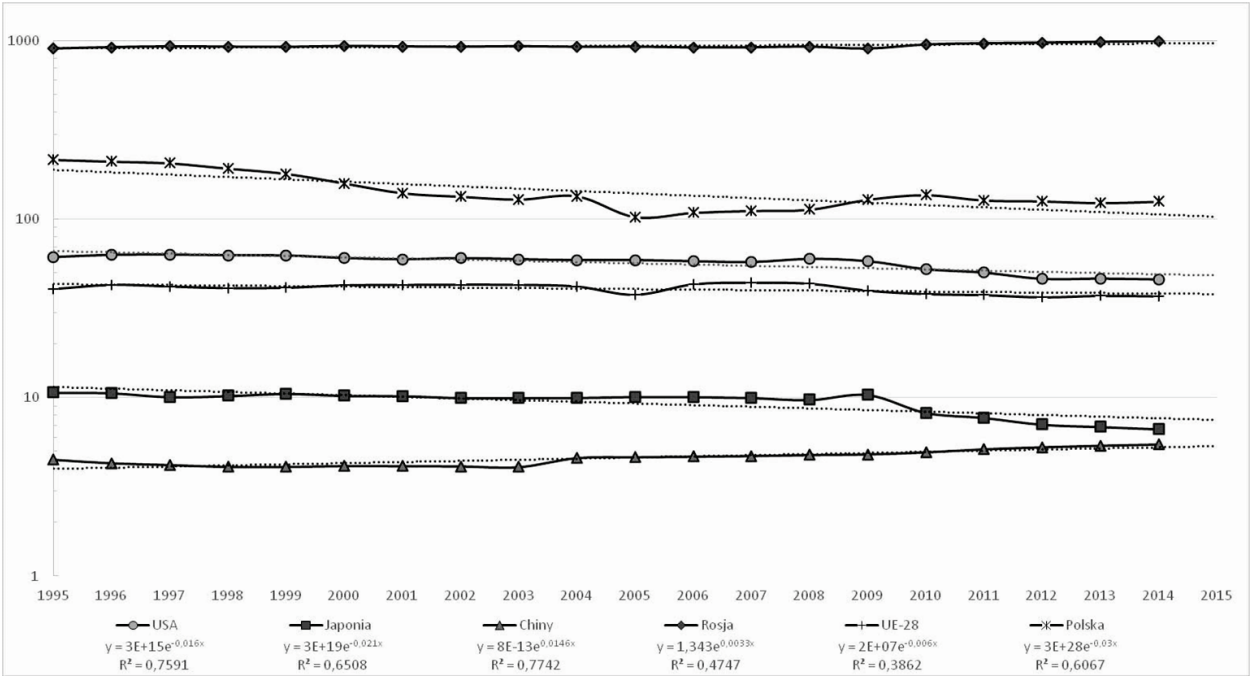

Fig. 3. Transport intensity of the selected economies of the world, using a logarithmic scale (source: own study based on Mindur M., 2010, Chapter 7; *Statistical Yearbook...; Figures in Europe...; Japan Statistical Yearbook...; China Statistical Yearbook...; Russia in Figures*...).

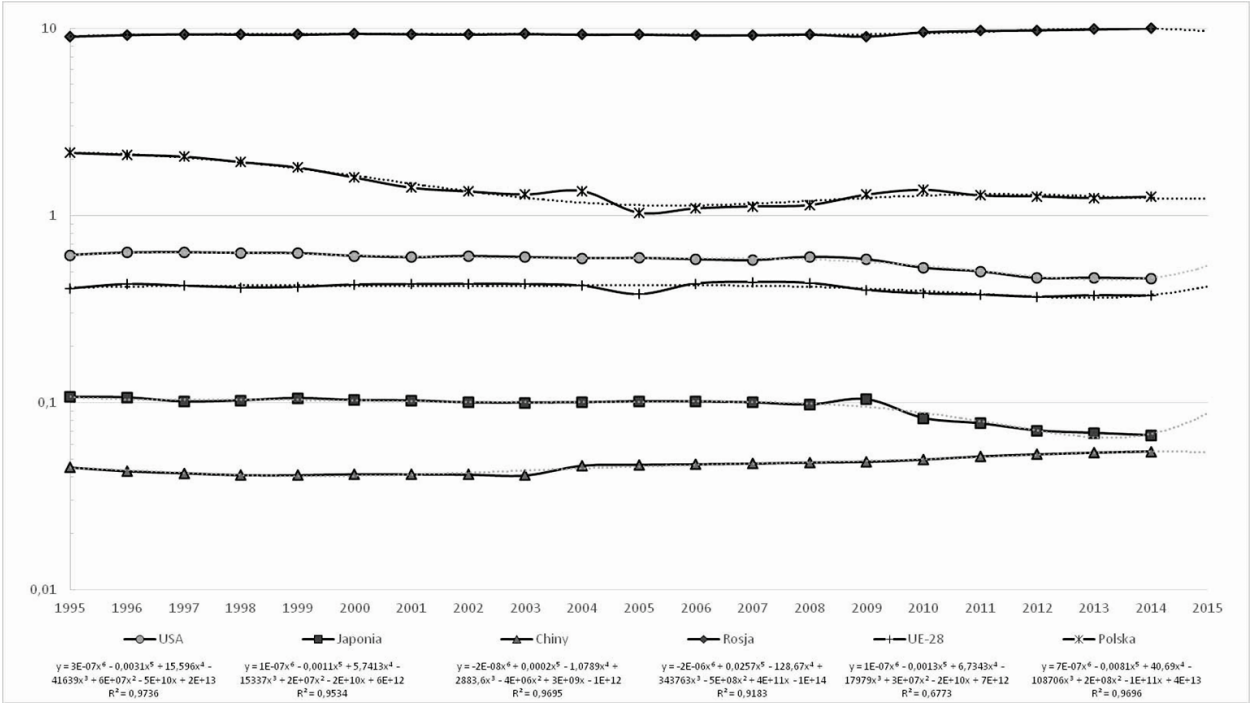

Fig. 4. Transport intensity of the economies of selected countries (using a logarithmic scale) (Source: own study based on Mindur M., 2010, Chapter 7; *Statistical Yearbook...; Figures in Europe...; Japan Statistical Yearbook...; China Statistical Yearbook...; Russia in Figures...*).

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

- During the period considered in the same (similar) very high level of transport intensity was maintained in Russia, and the study based on the exponential function of transport intensity in Russia does not seem plausible, because the rate of compliance is low R^2 (R^2 = 04747). Better results have been achieved by making a survey based on polynomial curve - the compatibility factor R^2 (in this case) reached 0.9183.
- Transport intensity in the US and Japan in 1995-2008was on a stable but significantly lower level as compared with Russia, while from 2008 until 2015 a slight decline followed in the US, and in Japan, after a slight increase in 2009, there was a marked reduction in transport intensity until 2015. The same as in the case of Russia, better compliance coefficients R^2 in the USA and in Japan were achieved by making a test based on the polynomial curve (0.9736 and 0.9534, respectively) compared to test for the exponential curves, wherein R^2 compliance rates were respectively 0.7591 and 0.6508.
- In the EU-28 transport intensity from 1995 until 2004 was at the same level. In 2005 a decline takes place, and from 2006 it reaches the level of pre-2004. It stays level until 2015. The study is based on the polynomial curve to the compatibility factor R^2 = 0.3862 and are unreliable. A higher rate of the compliance coefficientR^2 was reported in the examination based on the polynomial curve, which has a value of 0.6773.
- In China transport intensity of the national economy in the years 1995-2015 is characterized by a small increase. Studies based on both the curve of the exponential function, and polynomial curve tend to be relatively high, and are respectively 0.7742 and 0.9695.
- In Poland transport intensity from 1995 until 2003 decreases, and in 2004, slightly increases, in 2005 a decrease can be observed and then until 2015 it has a slight upward trend. R^2 compliance coefficients of the compatibility test, based on exponential and polynomial curve are respectively 0.6067 and 0.9696.

3. SUMMARY

Transport intensity test results for the period 2007–2010 fully confirm the conclusions from the analyses of this area before 2007.

In the years 1995–2015 the dynamic growth of GDP can be observed (from a high initial level) in the US and the EU-28. Equally dynamic (with much lower initial level) GDP growth takes place in China. A balanced upward trend (with a fairly high level) in the analyzed period is for GDP in Japan. Moderate growth trends (from a very low initial level) have gross domestic products in Russia and Poland (see Fig. 1).

The analysis of cargo shipments in total in the examined time horizon for the selected countries, based on the polynomial curve (see Fig. 2) allows to observe considerable convergence in shaping them in the United States, Russia and the EU-28. In all three cases fairly similar (average) initial level in 1995-2008, carriages show a clear upward trend. In 2009 a decline is observed, and then in 2015 a dynamic growth. In China, from a much lower initial level from 1995 to 2005 are at an even level, and from 2005 until 2015 followed a clear upward trend. In Poland carriages, throughout the period considered, are on an even low level. In Japan, at a slightly higher level than in China and Poland, carriages stay at balanced level in 1995–2007, and from 2007 until 2015 a decrease occurs. The large convergence in the formation of a polynomial curve showing the total GDP and transportation in total is worth emphasizing, which confirms the close relationship and interdependencies between economic development and transport. The compliance coefficients R^2 of the variables tested are reliable, fit for in the range of 0.9725 to 0.9954.

Transport intensity in Russia, over the period considered, is formed on an even, high level (see Fig. 3 and 4). In Poland, from 1995 to 2005 the downward trend can be observed, and from 2005 until 2015 it was followed by a gradual slight increase. In USA and Japan from 1995 until 2009 it remains at an even level, but from 2009 a considerable decline has been taking place. In the EU-28 and China transport intensity throughout the period considered remained at the same even level.

The results of the research carried out on transport intensity in the years 1995–2015 are only partly concurrent with the results of research conducted by the author between 2007 and 2010. In part this may be due to the fact that the results of a recent study on transport intensity were carried out on a much longer time series (20 years) than previously, which allowed to reduce the impact of side causes.

Satisfactory compliance coefficientsR^2were achieved with surveys based on polynomial curve for selected countries, and the EU-28. While lower values were obtained using surveys based on an exponential curve for the USA, Japan, China and Poland. Very low value of indicators of compliance R^2 was obtained for Russia ($R^2 = 0.47$) and the EU-28 ($R^2 = 0.3862$). Therefore, when examining transport intensity, the exponential function was used along with a polynomial function.

Stabilization of transport intensity throughout the period considered at a high, initial level takes place in Russia. The downward trend in transport intensity since 2009, takes place in the US and Japan. A small increase in transport intensity occurs in the EU-28 and in Poland and the slight upward trend in the whole study period can be seen in China.

The decrease in transport intensity in the US and Japan may mean that economic growth requires less commitment to transportation, because the progressive changes in the economic structures of these countries rely on ever greater share of the service sector and the introduction of new technologies.

Satisfactory compliance rates R^2 exponential functions are in the period China, the US, Poland and Japan, while the very low rate of compliance have variable Russia transport intensity ($R^2 = 0.4747$), and unconvincing compliance rates too low, had the EU-28 ($R^2 = 0.3862$). Therefore, the next test transport intensity exponential polynomial function is employed.

General conclusion that emerges from the analysis and trends shaping both polynomial curves of GDP and transport intensity, and curved exponential functions is that the dynamic growth of world GDP and total transport intensity in the selected countries of the world (which determines the economic potential the development of the world economy) and Poland showed stabilization (in the EU-28and Russia), while the downward trend in the period occurred in the US, Japan and Poland, only the Chinese economy shows a small increase. This may mean that the growth of the world economy requires less commitment to transportation - in connection with progressive changes in the structure of the global economy, involving a growing share of the services sector and the introduction of new technologies (more Mindur M., 2010).

The inhibition of growth of transport intensity in the developed countries of the world and decline in some of them may be due to the following factors (B. Liberadzki, Mindur L., 2007):

- rationalization of production activities (e.g. in terms of reducing transport);
- change in the structure of the economy (growth of the services 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) with regard to the quality of its services primarily in the area of full service transportation and logistics, timeliness of delivery, size of the consignment, the 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.).

Stabilization and decline in transport intensity in the countries surveyed (occurring to varying degrees) and inhibiting its growing trend in the EU-28 should be assessed positively, as this will result in lowering costs of production and services.

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