

## Transportation Volumes and Unevenness are Important Factors Affecting the Efficient Use of Transport Infrastructure

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### **Abstract**

The economic conjuncture of the transport industry is a system indicator of the state of the national economy. At the same time, transportation volumes have a decisive impact on the economic situation of transport, which can be generally analyzed based on the dynamics of transportation volumes. The purpose of this study is to identify the relationship between the volume and unevenness of transportation and the transport infrastructure use efficiency. The study of the relationship between the volume and irregularity of transportation and the transport infrastructure use efficiency was carried out using quantitative methods: a) Identification of the link between transport infrastructure development, transport dynamics, and economic growth; b) Analysis of traffic volumes as an indicator of the efficiency of transport economy and national economy; c) Analysis of changes in traffic volumes; d) Analysis of seasonal fluctuations in traffic; e) Comparison of the results and relationships establishment. The study results can be used to draw practically important conclusions for the implementation of measures to improve the efficiency of use and development of transport infrastructure. The analysis carried out in the article allows us to draw practical conclusions for the implementation of measures to improve the efficiency of use and development of transport infrastructure. First, there is a need for targeted measures in the framework of marketing and tariff policy to reduce (or at least prevent growth) transportation

*unevenness, which will increase the efficiency of the existing transport infrastructure and will allow obtaining the effect of the remoteness of investment in its development. The main tool for solving this problem is dynamic tariff formation. At the same time, it is advisable to assess the unevenness of traffic using the methodology proposed in the study. Secondly, to ensure the comprehensive development of transport infrastructure, large-scale projects should be complemented by local, implemented with the active involvement of private capital.*

### **Keywords**

*Law of advanced development of transport infrastructure; transport restrictions; the law of diminishing returns; economic growth; seasonal transportation unevenness; the effect of distancing capital investments.*

## **Introduction**

The economic conjuncture of the transport industry is a system indicator of the state of the national economy. At the same time, transportation volumes have a decisive impact on the economic situation of transport, which can be generally analyzed based on the dynamics of transportation volumes (Macheret, 2006, p. 4; Ryshkov, 2008). Thus, in the Russian Federation, the dynamics of freight rail transportation can serve as a representative indicator for assessing macroeconomic dynamics and identifying its specific phases (Macheret, 2009, p. 64). At present, in the context of the ongoing changes in the methodology and practice of assessing the value of macroeconomic indicators included in the national accounts system, the use of transportation volumes indicators with specific physical content can be very useful for understanding the real dynamics of socio-economic development.

The purpose of this study is to identify the relationship between the volume and unevenness of transportation and the transport infrastructure use efficiency.

## **Results**

As a long-term retrospective analysis shows, transport restrictions were significant barriers to modern economic growth, and only their removal allowed dramatically accelerating the development of the economy and improving the well-being of people. At present, when it is necessary to significantly accelerate the growth of the Russian economy, and the transport infrastructure condition is one of the factors constraining entrepreneurial activity, the growth of investment in transport infrastructure, opening up new opportunities for the activities of economic entities, should play an important role in solving this problem (Oreshkin, 2018, p. 8). At the same time, given the key role of railways in the country's transport system, the priority is the development of railway infrastructure (Ryshkov, Maksimushkin, & Postnikov, 2016, p. 12).

The total volume of cargo and passenger traffic, its structure, range, and related freight and passenger turnover are the key factors determining the operating costs of transport (Smekhova & Kozhevnikov, 2015). On the other hand, these indicators determine transport revenues. Thus, the traffic volume is crucial for the efficiency of the transport companies' current activities (Valeev, 2017, p. 26). Assessment of their prospective level allows planning in advance the activities for the transport

infrastructure development in accordance with the concept of predictive management of transport efficiency. At the same time, it is the economic value of the transport infrastructure that determines the value of the infrastructure itself (Macheret & Ledney, 2017, p. 13). Consequently, the modernization of existing and construction of new transport infrastructure can be effective only if the investment is justified by the value of the traffic.

It should be noted the importance of harmonious development of infrastructure of different transport modes, balanced with the level of load and the dynamics of traffic volumes on each of them. Currently, there are significant imbalances in this aspect, leading, in particular, to the overload of the railway infrastructure (Macheret & Ledney, 2018, p. 16). Meanwhile, the harmonious development of different transport modes within the unified transport system of the country was one of the goals of the Program of structural reform in railway transport, and its importance has not lost its relevance (Lapidus, Misharin, & Sharonov, 2001).

Thus, the volume of freight and passenger traffic, its dynamics, and modal distribution are key to the efficiency of the transport industry and serve as an important macroeconomic indicator. Improving the efficiency of the transport system of the country and the national economy as a whole in the long term requires a balanced development of transport infrastructure by mode of transport, taking into account the differences in the transportation dynamics of each transport mode. Based on the above, it is of great interest to analyze the volume and dynamics of freight and passenger traffic by mode of transport.

We will analyze the changes in the indicators of traffic volumes. Both from the point of view of infrastructure load (especially in those modes of transport where the routes are artificial – railways, highways, pipeline) and rolling stock, and from the point of view of the formation of revenues and costs of the transport industry, a key role is played by such indicators of traffic volumes as freight and passenger traffic, taking into account also the transportation distance. Of interest is the analysis of these indicators by transport modes over the past three years, when, after the decline in GDP in 2015, its growth continued.

Next, let us consider how the transport system of the country reacted to the improvement of the main macroeconomic indicator. In General, over these three years, the dynamics of both freight and passenger turnover significantly exceeds the dynamics of GDP (table.1), which confirms the need for advanced transport infrastructure development.

**Table 1. Dynamics of GDP of the Russian Federation, freight and passenger traffic of the country's transport system, 2017-2019**

Indicators	Growth rate to the previous year, %			Growth rate 2019 to 2016, %
	2017	2018	2019	
<b>GDP</b>	101,6	102,3	101,3	105,3
<b>Freight Turnover</b>	105,5	102,7	100,6	109,0
<b>Passenger Turnover</b>	109,0	105,8	107,3	123,7

*Compiled by the authors according to Rosstat (Rosstat, 2018, 2019).*

It is worth noting that in some years the ratio of changes in the indicators moves in different directions (Table 1). Changes in cargo and passenger traffic by transport modes significantly differ (Tables 2, and 3).

**Table 2. Dynamics of freight turnover of the Russian Federation transport system by mode of transport, 2017-2019**

Transport mode	Growth rate to the previous year, %			Growth rate 2019 to 2016, %
	2016	2017	2018	
<b>Railway</b>	106,4	104,2	100,2	111,09
<b>Automotive</b>	102,2	102,3	105,8	110,61
<b>Sea</b>	106,3	73,7	99,0	77,56
<b>Inland water</b>	100,0	98,4	95,1	93,58
<b>Air</b>	118,9	99,4	95,4	112,75
<b>Pipeline</b>	105,1	102,0	100,7	107,95
<b>Total</b>	<b>105,5</b>	<b>102,7</b>	<b>100,6</b>	<b>109,00</b>

*Compiled by the authors according to Rosstat (Rosstat, 2018, 2019).*

**Table 3. Dynamics of passenger traffic of the Russian Federation transport system by means of public transport, 2017-2019**

Transport mode	Growth rate to the previous year, %			Growth rate 2019 to 2016, %
	2017	2018	2019	
<b>Railway</b>	98,8	103,2	103,2	105,2
<b>Automotive (buses)</b>	99,3	97,5	98,7	95,6
<b>Air</b>	120,3	111,1	112,6	150,5
<b>Total</b>	<b>109,0</b>	<b>105,8</b>	<b>107,3</b>	<b>123,7</b>

*Compiled by the authors according to Rosstat (Rosstat, 2018, 2019).*

It is noteworthy that the highest dynamics in both indicators is air transport. This is obviously due to the priority of speed for the movement of both goods and people (Lapidus & Macheret, 2013).

As a result of the analysis of traffic volumes as an indicator of the efficiency of the transport and national economy of the Russian Federation, it was revealed that in the second place (after aviation) in terms of cargo and passenger turnover dynamics for the last three years is railway transport. It is noteworthy that the modeling of long-term changes in the speed parameters of the railway infrastructure also revealed a trend of exponential growth of traffic speeds with the prospect of reaching a radically new level (Macheret & Razuvaev, 2018, p. 48).

The share of railways in the freight turnover of the country's transport system is steadily growing (Table 4).

**Table 4. Changes in the structure of freight turnover of the Russian Federation transport system by transport mode, 2017-2019**

Transport mode	Share in freight turnover, %		
	2017	2018	2019
<b>Railway</b>	45,48	46,10	45,87
<b>Automotive</b>	4,62	4,60	4,85
<b>Sea</b>	0,84	0,65	0,64
<b>Inland water</b>	1,23	1,17	1,16
<b>Air</b>	0,14	0,14	0,13
<b>Pipeline</b>	47,70	47,34	47,34
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

*Compiled by the authors according to Rosstat (Rosstat, 2018, 2019).*

As for the passenger transportation market, the leader is air transport, which performs more than half of the total passenger turnover (table.5).

**Table 5. Changes in the passenger traffic structure of the Russian Federation transport system by means of public transport, 2017-2019**

Transport mode	Share in passenger turnover, %		
	2017	2018	2019
<b>Railway</b>	24,69	24,38	23,44
<b>Automotive (buses)</b>	23,27	21,61	19,89
<b>Air</b>	52,03	54,01	56,67
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

*Compiled by the authors according to Rosstat (Rosstat, 2018, 2019).*

Concerning the market of passenger traffic, it is worth noting that the leader is air transport, which performs more than half of the total passenger turnover.

It is particularly worth noting the problem of seasonal irregularity of freight and passenger traffic. Traditionally, it is calculated as the ratio of the "maximum monthly volume of traffic [in tons. – auth.] to the monthly average for the year", "the maximum monthly traffic volume to the minimum" and "the traffic volume of each month to the monthly average» (Tereshina & Lapidus, 2011).

However, in this assessment, there is a significant error due to the different number of days in months, so it is advisable to use the average daily values for each month (Macheret, 2015). In addition, the load on the infrastructure is determined not only by the number of transported tons or passengers but also by the range of their transportation. Therefore, from the point of view of the transport infrastructure use and consideration of options for its development, it is preferable to use the indicators of freight turnover and passenger turnover to assess the unevenness of transportation.

**Table 6. The unevenness of the freight turnover of the Russian Federation transport system, 2017-2019**

Year	The ratio of the average daily turnover of each month to the average daily turnover for the year, %												The ratio of the maximum average daily turnover per month to the average daily turnover per year, %	The ratio of the maximum average daily turnover per month to the minimum, %
	January	February	March	April	May	June	July	August	September	October	November	December		
2017	99,8	100,5	99,2	98,1	98,5	98,4	97,4	98,9	100,7	103,3	102,9	102,3	103,3	106,1
2018	98,1	99,6	100,7	100,1	98,8	97,7	98,6	98,7	100,0	102,0	103,0	102,7	102,7	105,1
2019	100,0	100,9	102,7	102,1	99,2	97,7	97,3	97,7	99,7	101,6	100,5	100,7	102,7	105,6

Compiled by the authors according to Rosstat (Rosstat, 2018, 2019).

**Table 7. The unevenness of the passenger traffic of the Russian Federation transport system, 2017-2019**

Year	The ratio of the average daily passenger turnover of each month to the average daily for the year, %												The ratio of the maximum daily average for the month of passenger traffic to the average daily for the year, %	The ratio of the maximum average daily passenger turnover per month to the minimum, %
	January	February	March	April	May	June	July	August	September	October	November	December		
2017	81,1	80,7	83,0	88,8	95,4	115,8	130,4	131,1	114,5	97,3	90,9	89,5	131,1	162,4
2018	82,8	81,2	83,5	89,2	93,7	115,7	127,5	129,7	116,5	98,1	92,0	88,8	129,7	159,8
2019	82,2	80,8	85,7	89,1	97,1	115,4	127,4	129,4	114,7	99,2	90,2	87,3	129,4	160,1

Compiled by the authors according to Rosstat (Rosstat, 2018, 2019).

The calculations of the estimation of seasonal traffic unevenness for the transport system of the Russian Federation for the period 2016 – 2018 (tables 6, 7) indicate a tendency to reduce the unevenness of both cargo and passenger turnover in the period under review.

The reduction of unevenness has had an important impact on the ability to meet the growing demand for freight and passenger transportation under infrastructure constraints. Thus, with the overall growth of the average daily cargo turnover of the transport system in 2018 compared to 2016 by 8.8%, the average daily cargo turnover per month of the most intensive traffic (in 2016 it was December, in 2018 – November) increased by only 3.8%. With the overall growth of the average daily passenger turnover of the transport system in 2018 compared to 2016 by 16.2%, the average daily passenger turnover in the month of the most intensive traffic (August) increased significantly less – by 12.5%.

If there had been no reduction in the unevenness of traffic, the increase in freight and passenger turnover in the whole year could have been less due to the limited transport capacity. This would have a negative impact on both the development of the economy and the realization of the needs of citizens. Further reduction of non-uniformity of traffic is desirable. It will create an opportunity to use the reserves of transport capacity to increase traffic volumes, generating the effect of the distance of capital investments in their development, increasing the productivity of infrastructure, labor, and rolling stock. And increasing the productivity of these main transport resources is the basis for reducing the cost of transportation.

At the same time, the uneven turnover of the transport system is already small. It seems that the practical possibility of its further reduction is limited to the range of 1-2 percentage points. Uneven passenger traffic is significantly higher, but its high level is objective, as it is associated with summer holidays. Therefore, the further growth of cargo and passenger turnover can be realized to a lesser extent by using the reserves of transport capacities during their underutilization and to a greater extent – by increasing the production capacity of transport. From this point of view, the main problem is the development of infrastructure – the most capital-intensive element of transport production. If the seasonal unevenness of transport not only fails to be reduced to an even greater extent but for some reason, it will increase (such risks always exist), this problem will become even more acute.

Its high relevance is also determined by the fact that the plans for the development of infrastructure, defined by the Transport strategy of the country, are not fully implemented (Macheret & Ledney, 2018, p. 13). An important role in accelerating the development of transport infrastructure should be played by the implementation of a comprehensive plan for the development of the main infrastructure, adopted by the Russian Government on September 30, 2018, which provides for several major projects covering all types of transport (Macheret & Ledney, 2018, p. 16). It seems that such large-scale projects envisaged by state decisions and implemented with the use of budget funding should be supplemented by "grass-roots" intensification of transport infrastructure development, which would solve the problems of the "last mile", local

transportation, etc. This requires the use of private capital, which requires an appropriate institutional environment.

The combination of implementation of large-scale and local projects will allow providing really complex development of transport infrastructure, to create conditions for further growth of transportations, the solution of the problems connected with their seasonal fluctuations, so – for economic growth and dynamic social development.

## Conclusions

The analysis carried out in the article allows us to draw practically important conclusions for the implementation of measures to improve the efficiency of use and development of transport infrastructure.

First, there is a need for targeted measures in the framework of marketing and tariff policy to reduce (or at least prevent growth) transportation unevenness, which will increase the efficiency of the existing transport infrastructure and will allow obtaining the effect of the remoteness of investment in its development. The main tool for solving this problem is dynamic tariff formation. At the same time, it is advisable to assess the unevenness of traffic using the methodology proposed in the study. When planning the development of transport infrastructure for promising traffic volumes, it is necessary to take into account not only their overall level but also seasonal unevenness, as infrastructure development should allow performing maximum volumes of traffic.

Secondly, to ensure the comprehensive development of transport infrastructure, large-scale projects should be complemented by local, implemented with the active involvement of private capital. Reducing the unevenness of transportation requires the creation of using the transportation reserves capacity possibilities to increase the traffic volume, generating the capital investments distance effect in capacity development. Improving the key transport resources productivity, such as infrastructure, labor, and rolling stock, is the basis for reducing transport costs.

It is also worth noting that the reduction of seasonal unevenness of transportation, combined with the solution of the problems of long-term transport infrastructure development, will contribute to the improvement of both industry and national economic security of the country.

With the development of the present study direction, a more detailed study of the methodological approach to assessing the transportation unevenness, taking into account the increase in the transport infrastructure value on specific sections of the railway track, is expected.

The study identifies ways to minimize transport restrictions, which can be significant barriers to the growth of transport infrastructure efficiency and economic development of the country, as well as the growth of the population welfare. This is particularly relevant in the context of the global political and economic crisis.

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