# ESTIMATION OF DEPENDENCE OF PASSENGER TURNOVER OF TRANSPORT ON MACROECONOMIC FACTORS

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## ABSTRACT

The instability of the domestic transport services market, significant fluctuations in demand on the part of the population, make it necessary to evaluate the range of problems under study with particular attention. The author analyzes the impact of macroeconomic factors on passenger traffic. The article reveals the high dependence of the total passenger flow on the economic condition of the country, the population's solvency margin. The change in the strength of the connection between passenger turnover and GDP over the last 24 years is considered. It is suggested that there is some «inertia» of transportation indicators and, at the same time, the predominant coincidence of the dynamics of the gross domestic product and the total passenger flow is analytically proved.

*Keywords: transport, macroeconomic factors, passenger transportation, forecasting, GDP, passenger turnover, interdependence of indicators.*

**Background.** *It is natural to believe that the main indicators of passenger transportation depend significantly on macroeconomic factors. And if this is the case, then analysis of the dependence of this market on the general level of the country's economic development, the potential of its productive forces, and at the same time forecasting possible changes in the industrial competitive environment, is needed to develop the strategies of transport companies, direct participants in the passenger transportation market [1–4].*

*Such an analysis may include the study of factors affecting passenger transportation, identification of the degree of their impact on the nature of employment and social mobility, methods for forecasting the demand of the population for transportation [5].*

**Objective.** *The objective of the author is to consider the dependence of passenger transportation indicators on macroeconomic factors.*

**Methods.** *The author uses general scientific methods, statistical method, comparative analysis, evaluation approach, graph construction.*

**Results.**

**Regularities of relations**

*The study of the dependence of the quantitative characteristics of the transport industry on economic indicators was carried out, for example, in [2, 6, 7]. So, in [2] the close connection between freight turnover of a railway transport and GDP which is kept during very long time is shown. For passenger turnover, there is a more complex and less obvious connection. In [7], some regional features of such dependences are considered.*

*It is possible to single out various factors that affect the volume of passenger transportation. Among them, of course, there are general socio-economic characteristics of the country. Factors related to the standard of living: real income of the population, average wages, unemployment rate, purchasing power parities of national currencies in accordance with the basic approach of international macroeconomic comparisons [8]. The number of personal vehicles owned by the population is also a factor that largely determines competition in the transport sector.*

*Of course, an important indicator for passenger transportation is the quality of transport work [9], the degree of satisfaction of passengers. The concept of quality of transport services is discussed, in particular in [9–11]. This factor is particularly significant in the competitive struggle between modes of transport.*

*On the one hand, when the economy is growing, the total demand for transport services is growing, which can improve the performance of any mode of transport. On the other hand, interspecific competition is increasing. Passengers taking into account factors such as price, the above-mentioned quality of service, the duration of the journey, choose the most suitable way of travel and comfort level.*

*Since in this paper the overall passenger turnover of all modes of transport is considered, it is logical, first of all, to assess its dependence on GDP (gross domestic product) – the main characteristic of the country's economic development.*

*In previous studies [13, 14] it was revealed that the level of economic development of the country has a significant, determining influence on the overall passenger turnover of transport.*

*We note that macroeconomic characteristics, having a significant impact on passenger turnover and freight turnover of all types of transport, are thus of decisive importance for virtually all indicators of the transport sector [15, 16].*

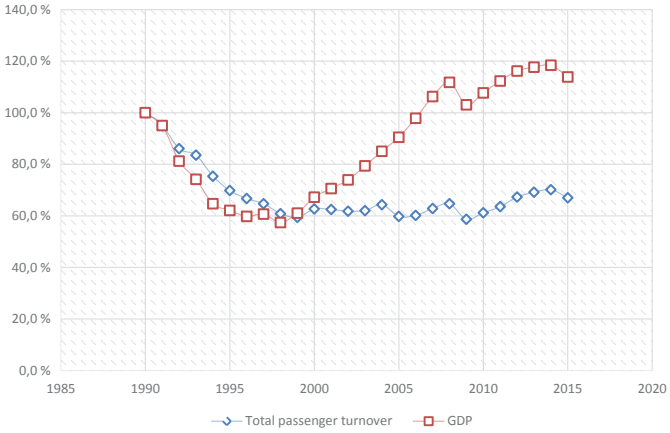
*In order to be able to compare the GDP values for different years, in the future gross domestic product is measured in billions of dollars in 1990 prices. The passenger turnover is measured in billions of passengers-km.*

*Table 1 provides information on both passenger turnover and GDP for the period from 1991 to 2015. The changes in values in percent to the previous year are given.*

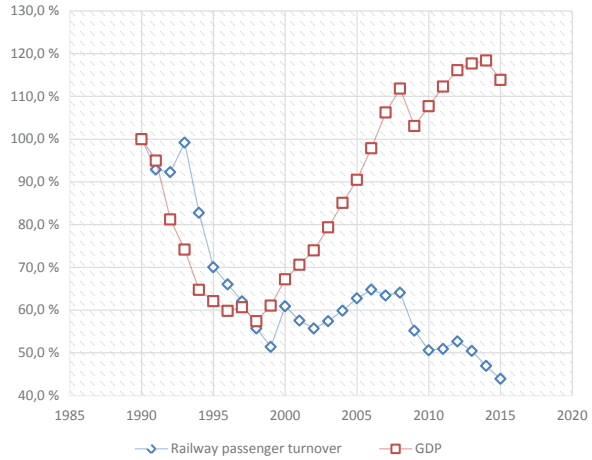
**Table 1**

**Dynamics of passenger turnover and GDP in percent to the previous year**

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pass. | -5,0 % | -9,4 % | -2,9 % | -9,8 % | -7,4 % | -4,4 % | -3,1 % | -5,9 % | -2,4 % | 5,6 % | -0,4 % | -1,0 % |
| GDP | -5,0 % | -14,5 % | -8,7 % | -12,7 % | -4,1 % | -3,6 % | 1,4 % | -5,3 % | 6,3 % | 10,0 % | 5,1 % | 4,7 % |
| | | | | | | | | | | | | |
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| Pass. | 0,4 % | 3,7 % | -7,1 % | 0,6 % | 4,4 % | 3,0 % | -9,4 % | 4,3 % | 3,9 % | 5,9 % | 2,7 % | 1,4 % |
| GDP | 7,3 % | 7,2 % | 6,4 % | 8,2 % | 8,5 % | 5,2 % | -7,8 % | 4,5 % | 4,3 % | 3,4 % | 1,3 % | 0,6 % |




***Pic. 1. Passenger turnover in transport and GDP in per cents to the indicators of 1990.***




***Pic. 2. Passenger turnover of transport and GDP in per cents relative to the indicators of 1990.***

*Analyzing the table, it is possible to see that the overall passenger turnover, as a rule, increases with GDP growth and decreases with its fall. In the period under consideration, for 20 years out of 25 there is the same direction of changes in GDP and passenger flow. In the period from 1990 to 1998, there was a synchronous decline in both values, only in 1997 there was a difference: passenger turnover fell, and GDP slightly increased.*

*Synchronicity in changes in indicators was observed after 2007. Growth and decline took place simultaneously. Interestingly, both the percentages of growth and decline are similar. Mutual decline occurred in 2009 and 2015 – a consequence of economic crises.*

*Only the period from 2000 to 2006 is marked by some violation of synchronicity. During these years, GDP showed significant growth, while passenger turnover either grew insignificantly or declined. It was at this time that the relative indicators of GDP were significantly higher than the figures for passenger turnover. In 1999, the volume of passenger turnover was 59 % of the figure of the year 1990; the GDP was 61 % of the value of the year 1990. And in 2007, the corresponding indicator for passenger turnover was 63 % (about the same value as in 1999), for GDP – 106 %.*

*For convenience and visibility, the values of GDP and passenger turnover are presented in the form of a graph in Pic. 1. This graph shows the GDP and passenger turnover figures for years as a percentage relative to 1990.*

**Correlation and graphical analysis**

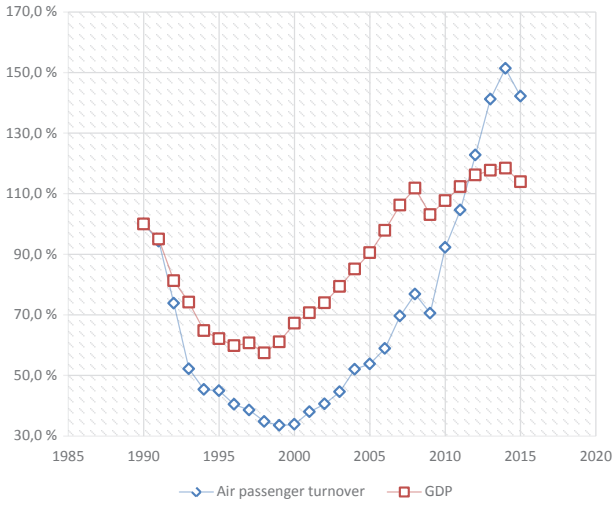
*To analyze the strength of the relationship between different characteristics, the correlation coefficient is usually used [12] – the main quantitative evaluation of the relationship of numerical values. Let's consider the correlation between total passenger turnover and Russia's GDP. If we calculate the correlation coefficient between them from 1991 to 2015, we get an incredible result. The coefficient is 0,07 (!) – this is a fantastically small value. It would seem that from here we can conclude that there is no connection between GDP, and hence the economic development of the country, and passenger turnover.*

*However, in this case, we should not completely trust the numbers. If we look at Pic. 1, we can see that the forms of GDP and passenger turnover graphs almost coincide, especially on segments that include the 90s and years from 2007 to 2015.*

*As already noted, in the observed period of time in about 80 % of the cases (19 years out of 24) the years of GDP growth and decline coincided with the growth and fall in passenger turnover.*

*If we consider the correlation between total passenger turnover and GDP for the years from 1990 to 1999, we obtain a coefficient of 0,95. This is a very high indicator. Also a very strong relationship between the values is evident if the correlation coefficient for the period from 2007 to 2014 is calculated to be 0,87.*

*Both of these values were greatly reduced after the crises of 1998 and 2008. On the graph, the practically synchronous conduct of GDP and passenger turnover after the crisis of 2008 is*




***Pic. 3. Passenger turnover of transport and GDP in per cents relative to the indicators of 1990.***

*especially vividly visible: decrease, recovery, then in 2013–2014 the growth slowdown, in 2015 with the beginning of a new crisis mutual decline.*

*We also note that in the 2000s, even with sufficiently synchronous behavior of two values, GDP growth was much faster than the growth of passenger turnover. So GDP had already reached the level of the year 1990 by 2007, and in 2014 it was 118 % of the level of 1990. Passenger turnover, despite the growth in the period from 2007 to 2014, in contrast to GDP has not reached the level of the year 1990. The maximum value – in 2014 – was 70,1 % in relation to the passenger turnover of 1990.*

*There are various reasons for this. Perhaps the ratio between the prices for transportation and the income of the population has changed. The structure of expenditures has also changed, so even with the growth of GDP and, accordingly, the average income, the transport activity of the population is growing at a slow pace. It can also be assumed that the growth of macroeconomic indicators is unevenly distributed among different population groups. Therefore, the opportunities for travel, especially long-distance, respectively, and transport activity grows not for the entire population, but only for a certain proportion. This also leads to the fact that GDP growth, although accompanied by an increase in passenger turnover, but significantly less in value.*

*For different modes of transport, there are different trends in the change in passenger flows and a different ratio of passenger turnover to GDP. Figures 2 and 3 show graphically the GDP and passenger turnover of rail and air transport. All data are presented in percentages relative to 1990 for the possibility of comparing the change in values.*

*The study of the influence of macroeconomic factors on distribution of demand for transportation by different modes of transport, a change in this distribution over time is a topic for a separate study.*

*We note various trends for two most important types of transport in terms of transportation volumes. Railway transport in recent years has not shown an increase in passenger turnover, even with growing GDP. Air transport, on the contrary, grew with GDP, at a much higher rate. Of all modes of transport, GDP growth in the 2000 was reflected positively primarily on air transport. In 2015, passenger turnover of air transport was 142 % compared to 1990, while passenger turnover of railway transport was only 44 % [18].*

**Conclusions.**

*1)* **Passenger turnover has a very strong dependence on the economic state of the country.** *This can be seen both from graphical analysis, and from the values of correlation coefficients over certain time intervals, and from a comparison of the values of two values: GDP and passenger flow. Moreover, the state of the country's economy (and GDP as its main indicator) is the main factor affecting the overall passenger turnover of transport. The extremely small value of the correlation coefficient for the entire period under consideration in this case is not indicative.*

*2)* **Passenger turnover has certain inertia.** *With a sharp decline in GDP, it may first fall at not so strong rates, as with the rise in GDP, the growth in passenger turnover may be slower. That is, some time lag between economic changes and the reaction of passenger turnover is not excluded. Thus, in the early 1990s, when the previous economic system was broken, the GDP and passenger turnover fell simultaneously, but passenger turnover fell at a somewhat slower pace. After the 1998 crisis, GDP began to recover in the next 1999, and passenger traffic still continued to fall, reaching its minimum value of 470 billion passenger-kilometers or 59,4 % of 1990 [13]. The fact that the indicators of passenger transportation after crises continue to decline for some time, it is easy to explain, both with economic and psychological reasons. People who have experienced some financial difficulties during the crisis may continue to face its consequences. Most of the population for the next year after the crisis will prefer to make some savings, spend money on essential goods, and only then make long trips.*

*3)* **The particularly pronounced dependence between passenger turnover and GDP becomes for time intervals of 7–10 years**. *Indeed, for the periods from 1990–1999 and 2007–2015, a very strong correlation relationship is determined, graphs, which are almost coincidental in shape, are observed. On longer segments, the quantitative indicators of communication lose their significance. Various political and structural changes change the figures in the ratio between GDP and passenger turnover. Perhaps the share in GDP and the income of the population that is spent on transport varies, but the real strong dependence still remains.*

*4)* **Passenger turnover also depends on other political and economic factors.** *Many of them*

*cannot always be quantified. For example, in 2005, one of the strongest falls in passenger turnover occurred – by 7,1 %, but GDP grew by 6,4 %. The most likely its role was played by the entry into force of the law on the monetization of benefits. This is confirmed by the fact that the most significant decrease in passenger turnover occurred in such types of transport as bus, trolley and tram, metro. Let's also note that most of passenger transportation (including suburban) remains subsidized. The change or reduction of subsidies for transportation by the state or individual subjects of the Russian Federation can affect the transportation performance, while not changing the GDP or increasing the effect of decline for passenger turnover.*

*5) When considering the dynamics of changes in passenger turnover and its connection with GDP in recent Russian history, it makes sense to break this period into 3 time periods: the first from 1990 to 1999; the second – from 2000 to 2006; and the third – from 2007. Each of these time segments is characterized by different trends in terms of the relationship between the volume of passenger turnover and macroeconomic characteristics. In particular, within these periods, a stable correlation coefficient between the quantities under consideration is determined, which is substantially different between the periods. The first and third periods are characterized by a very high correlation between GDP and total passenger turnover, an almost complete coincidence of the direction of changes in these quantities. The second time interval, on the other hand, is characterized by the absence of a positive correlation and a violation of the connection (or a change in its structure) between the quantities. In these time segments there is also a different dynamics of changes in the distribution of passenger turnover by mode of transport.*

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