The Impact of Logistics Infrastructure of the Federal Districts of the Russian Federation on Its Economic Indicators

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Abstract. The article is devoted to solving the actual problem of the construction of the linear multiple regression model, establishing the relationship between the economic indicators of the Russian Federation and the logistics infrastructure of the Federal districts. The obtained equation allows to identify the objects of the logistic infrastructure that have the greatest impact on the dependent variables, and to assess the degree of contribution of each component to the change in the resulting variable using multiple regression. The solution to this problem can be used in the elaboration of integrated development plans for the Federal districts of the country. The methodological tools of this study includes correlation analysis, Kolmogorov – Smirnov test, multiple regression analysis. The values of the indicators are taken for the period 2004 - 2016. As a result of the study using the IBM SPSS Statistics 20 program, the objects of the logistics infrastructure of the Federal districts that have the greatest impact on the economic performance of the Russian Federation were identified. It is shown that the transport and logistics infrastructures of St. Petersburg, the Krasnodar Territory, the Kirov, Sverdlovsk and Novosibirsk Regions as well as the volume of imports of goods in the Stavropol Territory and the number of transport enterprises in the Republic of Dagestan have the greatest impact on the dependent variables. An increase of the dependent variables by one percentage point will lead to an increase in the economic indicators of the Russian Federation from 0.74% to 1.01%.

1. Introduction

To implement the transition from the export of raw materials to innovative scenario the Concept of long-term socio-economic development of the Russian Federation for the period until the year 2020 foresees the development of both traditional sectors of the economy (energy, transport, agriculture), and other economically important industries. One of the most important conditions for realization of the Concept is the dynamic development of the transport infrastructure of the Russian Federation.

Currently, a significant amount of works on the relationship of the economic indicators and the transport infrastructure of the constituent entities of the Russian Federation are presented. In particular in the work of Lukinskiy V.S. [1] a measure of the relationship between transport and logistics infrastructure of Saint Petersburg and gross national product is determined. In the work [2], it was shown that improving the quality of the transport and logistics system by 10% leads to an increase in export by 2% in the exporting economy and an increase in import by 3% for the importing economy. In the works of Gerami V.D. and Kolik A.V. [3] a linear dependence between the factor variables of the logistics infrastructure and the gross region product was structured. It should be noted that the corrected coefficient of determination for this dependence was less than 0.6. In the work [4], the relationship between the level of development of the logistics infrastructure and the region economy was shown.
The relationship of the transport and logistics infrastructure of the Volgograd [5] and Astrakhan [6] Regions and their economic indicators was determined by the author of the article.

The purpose of this work is to establish a measure of the relationship between the key economic indicators of the Russian Federation and the logistics infrastructure of the Federal districts for 2004--2016, and also the identification of the components of the logistics infrastructure that have the most significant impact on the country's economy.

2. Initial data and research methods

The following independent indicators were chosen as the main components of the logistics infrastructure:

- volume of cargo carried, thousand tons (x₁);
- transportation of passengers by railway, thousand people (x₂);
- shipment of goods by railway, million tons (x₃);
- number of enterprises and transport organizations, pieces (x₄);
- transport of passengers by road, thousand people (x₅);
- dispatch of cargo by road, million tons (x₆);
- passenger traffic at airport, people (x₇);
- carriage of goods by air, tons (x₈);
- volume of imports of goods, million dollars (x₉);
- volume of exports of goods, million dollars (x₁₀);
- index of industrial production, % (x₁₁);
- carriage of passengers by waterway, people (x₁₂).

The following indicators were selected as characteristics of the financial and information component of the logistics infrastructure:

- the volume of foreign investments, million dollars (x₁₃);
- number of companies providing financial services, pieces (x₁₄);
- number of enterprises using ICT, pieces (x₁₅).

The key, (resultanting), economic indicators of the Russian Federation are:

- gross domestic product, billion roubles (y₁);
- investment in capital assets, billion roubles (y₂);
- consolidated budget revenues, billion roubles (y₃).

In order to identify the components of the logistics infrastructure that have the greatest impact on the economic performance of the Russian Federation as well as measures of their correlation the cumulative potential of the methods of multivariate analysis of variance and multiple regression analysis was used in the work. The calculation was carried out in the program IBM SPSS Statistics 20. As a method of research, the method of step selection was applied.

At the initial stage, in order to eliminate redundant variables, using the Pearson linear correlation coefficient, a measure of the correlation between the components of the logistics infrastructure and the economic indicators of the Russian Federation was determined. Independent variables were excluded from further research if the correlation coefficient $r_{xy} < 0.3$. At the second stage, based on an intercorrelation matrix a check for multicollinearity was carried out. The indicators of the logistics infrastructure with the largest number of values of the linear correlation coefficient exceeding 0.7 were excluded from further calculation. At the third stage, the remaining parameters of the logistics infrastructure were checked for compliance with the normal distribution law using the Kolmogorov - Smirnov test. Independent variables, the distribution of values in the sample of which did not correspond to the normal distribution law, were excluded from further consideration.

3. Results of research

After the estimation of the adequacy of the independent variables, an assessment of the possibility of constructing a linear multiple regression equation in IBM SPSS Statistics 20 was made. The overall
results of the multiple regression analysis on the economic indicators “Gross Domestic Product”, “Investments in capital assets” and “Consolidated budget revenues” show that the linear model of multiple regression is reliable for all Federal districts of the Russian Federation, since the regression model explains more than 80% of the variance of the dependent variable, and the value of F-Fisher does not exceed 5%. Based on this, the predicted values of the dependent variables can be taken into account.

It is proposed to assess the correlation between key economic indicators of the Russian Federation and the components of the logistics infrastructure. The values of the standardized coefficients of the linear multiple regression model are statistically significant, since the significance level does not exceed 5%. On this basis, it is possible to interpret the degree of influence of each component of the logistics infrastructure on the economic indicators of the Russian Federation.

The equations of linear multiple regression for the economic indicators of the Russian Federation using standardized coefficients can be represented as follows.

The Central Federal District:

\[ Y_1 = 0.47X_{\text{Moscow}} + 0.205X_{\text{Smolensk Region}} + 0.29X_{\text{Kostroma Region}} + 0.104X_{\text{Moscow Region}} \]
\[ Y_2 = 0.46X_{\text{Moscow}} + 0.233X_{\text{Krasnodar Territory}} + 0.376X_{\text{Kaluga Region}} + 0.085X_{\text{Moscow Region}} + 0.078X_{\text{Kostroma Region}} \]
\[ Y_3 = 0.286X_{\text{Moscow}} + 0.625X_{\text{Kostroma Region}} + 0.332X_{\text{Smolensk Region}} + 0.095X_{\text{Kostroma Region}} + 0.125X_{\text{Kostroma Region}} \]

The Northern-Western Federal District:

\[ Y_1 = 0.94X_{\text{St. Petersburg}} + 0.124X_{\text{Republic of Karelia}} \]
\[ Y_2 = 1.017X_{\text{St. Petersburg}} + 0.164X_{\text{Kalinigrad Region}} + 0.081X_{\text{Arkhangelsk Region}} + 0.203X_{\text{Kalinigrad Region}} + 0.156X_{\text{Kostroma Region}} \]
\[ Y_3 = 0.384X_{\text{St. Petersburg}} + 0.413X_{\text{Republic of Karelia}} + 0.152X_{\text{Novgorod Region}} + 0.095X_{\text{Murmansk Region}} + 0.056X_{\text{Pskov Region}} \]

The Southern Federal District:

\[ Y_1 = 0.753X_{\text{Krasnodar Territory}} + 0.32X_{\text{Krasnodar Territory}} \]
\[ Y_2 = 0.441X_{\text{Rostov Region}} + 0.665X_{\text{Krasnodar Territory}} + 0.2X_{\text{Rostov Region}} \]
\[ Y_3 = 0.796X_{\text{Krasnodar Territory}} + 0.197X_{\text{Krasnodar Territory}} + 0.171X_{\text{Volgodgrad Region}} \]

The North Caucasus Federal District:

\[ Y_1 = 0.768X_{\text{Republic of Dagestan}} + 0.238X_{\text{Kabardino-Balkar Republic}} + 0.14X_{\text{Chechen Republic}} \]
\[ Y_2 = 0.727X_{\text{Stavropol Territory}} + 0.446X_{\text{Kabardino-Balkar Republic}} + 0.19X_{\text{Chechen Republic}} + 0.248X_{\text{Lipetsk Region}} \]
\[ Y_3 = 0.743X_{\text{Republic of Dagestan}} + 0.135X_{\text{Stavropol Territory}} + 0.23X_{\text{Stavropol Territory}} + 0.131X_{\text{Stavropol Territory}} \]

The Volga Federal District:

\[ Y_1 = -0.538X_{\text{Penza District}} - 0.43X_{\text{Republic of Udmurtia}} + 0.243X_{\text{Saratov Region}} \]
\[ Y_2 = 0.592X_{\text{Ulyanovsk Region}} + 0.33X_{\text{Kirov Region}} + 0.177X_{\text{Republic of Mordovia}} + 0.155X_{\text{Republic of Mordovia}} \]
\[ Y_3 = 0.755X_{\text{Kirov Region}} + 0.444X_{\text{Republic of Tatarstan}} + 0.368X_{\text{Orenburg Region}} + 0.195X_{\text{Republic of Mari El}} \]

The Ural Federal District:

\[ Y_1 = 0.434X_{\text{Sverdlovsk Region}} + 0.389X_{\text{Chelyabinsk Region}} + 0.198X_{\text{Sverdlovsk Region}} \]
\[ Y_2 = 0.854X_{\text{Sverdlovsk Region}} + 0.139X_{\text{Chelyabinsk Region}} + 0.103X_{\text{Sverdlovsk Region}} \]
\[ Y_3 = 0.984X_{\text{Sverdlovsk Region}} \]

The Siberian Federal District:

\[ Y_1 = 0.85X_{\text{Republic of Khakasia}} + 0.158X_{\text{Kemerovo Region}} + 0.125X_{\text{Krasnoyarsk Region}} \]
\[ Y_2 = 0.878X_{\text{Novosibirsk Region}} - 0.211X_{\text{Krasnoyarsk Region}} + 0.138X_{\text{Krasnoyarsk Region}} \]
\[ Y_3 = 0.889X_{\text{Novosibirsk Region}} - 0.232X_{\text{Tomsk Region}} + 0.098X_{\text{Kemerovo Region}} \]

The Far East Federal District:

\[ Y_1 = 0.548X_{\text{Kamchatka Territory}} + 0.328X_{\text{Sakhalin Region}} + 0.365X_{\text{Kamchatka Territory}} \]
\[ Y_2 = 0.682X_{\text{Kamchatka Territory}} + 0.252X_{\text{Primorye Territory}} + 0.199X_{\text{Primorye Territory}} \]
\[ Y_3 = 0.349X_{\text{Amur Region}} + 0.203X_{\text{Primorye Territory}} + 0.314X_{\text{Sakhalin Region}} + 0.368X_{\text{Primorye Territory}} \]
Domestic Product» most significantly. An increase by one percentage point in the values of the components of the logistics infrastructure will lead to the economic growth of 0.94%, 0.753%, 0.85% and 0.768%, respectively.

The components of the transport and logistics infrastructure of St. Petersburg, Sverdlovsk and Novosibirsk Regions have the greatest impact on the indicator “Investments in capital assets”. An increase in the values of the above components by 1% will lead to an increase in the economic indicator by 1.017%, 0.854% and 0.878%, respectively.

The economic indicator “Consolidated budget revenues” is most affected by the transport and logistics infrastructure of the Krasnodar Territory, Kirov, Sverdlovsk and Novosibirsk Regions, as well as the predictor “The number of enterprises and organizations of transport” of the Republic of Dagestan. An increase in the values of the above components of the logistics infrastructure by 1%, while the other predictors will not change, will lead to an increase in the dependent variable by 0.796%, 0.755%, 0.984%, 0.889% and 0.743%, respectively.

Thus, the development of the transport and logistics infrastructure of the Federal districts of the Russian Federation will have a significant impact on the economic indicators of the Russian Federation, as well as will increase their investment attractiveness. The results obtained correlate well with the main tasks set out in the Concept for the long-term socio-economic development of the Russian Federation for the period up to 2020 (development of transport and energy infrastructure).

To determine the optimal location of transport infrastructure facilities (transport terminals, car parks, etc.) it is proposed to use the model and algorithm presented in the works [7-20].

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