

# Assessment of the relationship between the logistics infrastructure of the Ural Federal District and the economic indicators of the district and the country

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**Abstract.** The article shows the relationship between the logistics infrastructure of the Ural Federal District and the economic indicators of both the Russian Federation and the district. The parameters of the logistics infrastructure included indicators of its warehouse, transport, financial, and informational components. The analyzed data are for 2004-2018. To exclude redundant variables, they were tested for normality, multicollinearity, and the measure of the relationship with dependent indicators was assessed. The research method is multiple regression analysis. The study has proved that the relationship between economic indicators and independent variables can be represented as a linear multiple regression model. Based on the models obtained, the significant influence of the transport component of the logistics infrastructure of the Ural Federal District on the economic indicators of the country and the district is shown. The creation of logistics infrastructure development programs based on the results obtained will promote the socio-economic development and investment attractiveness of the district.

## 1 Introduction

One of the most important problems hindering the spatial development of the Russian Federation are infrastructural constraints common to the territories of the constituent entities. These restrictions, manifested in the insufficient and uneven development of transport and storage infrastructure, lead to a decrease in the transit potential of the Russian Federation.

Among the activities related to the spatial development of the Russian Federation, we should dwell on the actions aimed at eliminating infrastructure restrictions at both the federal and regional levels, as well as increasing accessibility in the energy, telecommunications, and transport sectors.

To overcome this problem, the Government of the Russian Federation approves national projects and programs, which will ensure the comprehensive development of the country's territories. In particular, in order to reduce economic interregional differences within the Ural Federal District, eliminate the imbalance in the development and investment attractiveness of the transport infrastructure of the constituent entity, the Government of the

Russian Federation approved the "Strategy for the socio-economic development of the Ural Federal District until 2020" - hereinafter the Strategy. This Strategy identifies key challenges that would increase the level of well-being of the population, as well as diversify the economic potential of the region.

The Strategy refers projects related to the improvement of transport and information infrastructures, as well as the quality of transport and logistics services, to the main development programs of the Ural Federal District (hereinafter UFD). Despite the fact that Euro-Asian transport corridors pass through the territory of the district, the existing infrastructure is poorly developed and is operated practically at the level of its design capacity. In addition, there is a strong disproportion in the development of the logistics infrastructure of the regions of the Ural Federal District.

To identify the priority directions of the development of the district in the field of transport infrastructure, the author examines the degree of influence of the key characteristics of the logistics infrastructure of the Ural Federal District on the economic indicators of the region and the Russian Federation.

## 2 Materials and Methods

The authors used independent variables related to the transport and storage component of the logistics infrastructure as indicators related to passenger and cargo transportation by road, rail, air, and water transport, export-import operations, industrial production and the number of transport enterprises [1-4].

The financial and informational component was represented by indicators related to foreign investment, the number of financial enterprises, and using information and communication technologies.

Dependent variables characterizing the economic indicators of the Russian Federation and the Urals Federal District were represented by the following parameters:

- gross domestic/regional product, billion/million rub. ( $y_1/y_4$ );
- investments in fixed assets, billion/million rub. ( $y_2/y_5$ );
- consolidated budget revenues, billion/million rub. ( $y_3/y_6$ )

The analyzed data are for 2004-2018. To comply with the requirements for the initial data, the used indicators were initially checked for all variables for compliance with the normal distribution law. The research applied the Kolmogorov-Smirnov test. If the distribution of values in the sample did not correspond to the normal, then these indicators were excluded from further consideration. After that, the closeness of the relationship between the characteristics of the logistics infrastructure and the economic indicators of the Russian Federation and the Urals Federal District was assessed using the Pearson's linear correlation coefficient. If the value of the correlation coefficient did not exceed 0.3, then these independent indicators were not considered in further research. The rest independent variables were tested for multicollinearity. For this, the Pearson's linear correlation coefficient was calculated between all independent variables. The indicators, for which  $r_{xy} \geq 0.7$  was the highest, were successively excluded from further consideration. Based on the fact that all indicators had different scales of measurement, the dependent and independent variables were z-scored. All calculations were performed in IBM SPSS Statistics 20.

To identify the degree of impact of the logistics infrastructure on the dependent indicators of the Russian Federation and the Ural Federal District, the authors used a linear multiple regression model. The model was built with IBM SPSS Statistics 20. For more accurate results, "automated linear modeling" was used. The research method is stepwise selection. To assess the meaningfulness of the resulting model, the adjusted R-squared was calculated, and a verification was carried out to identify deviations from standard

assumptions. Violations of standard assumptions (outliers, heterogeneity of variances, incorrect model specification) were identified using a plot of standardized residuals and the Goldfeld-Quandt test.

### 3 Results and Discussion

After excluding redundant variables, a linear multiple regression model was built for all economic indicators of the Russian Federation and the Urals Federal District.

The results obtained indicate the meaningfulness of the constructed models for all economic indicators, as the value of the adjusted R-squared exceeds 70%, while the Fisher test does not exceed 5% (Table 1).

**Table 1.** Model parameters

Dependent variable	Adjusted R-squared	Standard evaluation error	Fisher test	Significance
Russian Federation				
y <sub>1</sub>	0.995	1885.24	649.122	0.0001
y <sub>2</sub>	0.999	312.89	524.85	0.0001
y <sub>3</sub>	0.993	1403.15	339	0.0001
Urals Federal District				
y <sub>4</sub>	0.993	2105.86	534.031	0.0001
y <sub>5</sub>	0.989	632.31	327.149	0.0001
y <sub>6</sub>	0.758	1360.84	22.943	0.003

The coefficients for the indicators of the logistics infrastructure, as well as their significance and importance, are presented in Table 2.

**Table 2.** Coefficient statistics

Dependent variables	Indicators	Coefficients	Significance	Importance
Russian Federation				
y <sub>1</sub>	Constant term of the model	-0.095	0.016	-
	Passenger traffic at Koltsovo airport, people (x <sub>7</sub> )	0.691	0.0001	0.804
	The number of transport enterprises in the Chelyabinsk region, pcs. (x <sub>4</sub> )	0.266	0.017	0.196
y <sub>2</sub>	Constant term of the model	-0.072	0.006	-
	Passenger traffic at Koltsovo airport, people (x <sub>7</sub> )	0.806	0.001	0.524
	Imports of goods to the Kurgan region, \$ mil. (x <sub>9</sub> )	0.072	0.004	0.217
	Air cargo transportation at Kurgan airport, t. (x <sub>8</sub> )	-0.123	0.007	0.139
	The number of transport enterprises in the Chelyabinsk region, pcs. (x <sub>4</sub> )	0.286	0.009	0.119
y <sub>3</sub>	Constant term of the model	-0.236	0.02	-
	The number of transport enterprises in the Tyumen region, pcs. (x <sub>4</sub> )	0.652	0.0001	0.94
	Rail cargo transportation, mil. t., Chelyabinsk region (x <sub>3</sub> )	0.182	0.03	0.06

**Table 2.** Continued

UFD				
$y_4$	Constant term of the model	-0.087	0.037	-
	Passenger traffic at Koltsovo airport, people ( $x_7$ )	0.779	0.0001	0.913
	The number of transport enterprises in the Kurgan region, pcs. ( $x_4$ )	0.197	0.009	0.087
$y_5$	Constant term of the model	-0.093	0.054	-
	Passenger traffic at Koltsovo airport, people ( $x_7$ )	0.834	0.0001	0.902
	Imports of goods to the Sverdlovsk region, \$ mil. ( $x_9$ )	0.188	0.006	0.098
$y_6$	Constant term of the model	-0.118	0.431	-
	Passenger traffic at Koltsovo airport, people ( $x_7$ )	0.808	0.003	1.00

The results (Table 2) indicate the statistical significance of the coefficients of the constructed multiple regression models, with the exception of free terms, for the economic indicators "Investment in fixed assets, mil. rub." and "Revenues of the consolidated budgets, mil. rub." of the UFD.

Based on the obtained coefficients of the models and their significance, the equations for the studied economic indicators of the Russian Federation and the Ural Federal District are as follows:

$$Y_1 = 0,691X_7 \text{ Sverdlovsk region} + 0,266X_4 \text{ Chelyabinsk region} - 0,095$$

$$Y_2 = 0,806X_7 \text{ Sverdlovsk region} + 0,072X_9 \text{ Kurgan region} - 0,123X_8 \text{ Kurgan region} + 0,286X_4 \text{ Chelyabinsk region}$$

$$Y_3 = 0,652X_4 \text{ Tyumen region} + 0,182X_3 \text{ Chelyabinsk region} - 0,236$$

$$Y_4 = 0,779X_7 \text{ Sverdlovsk region} + 0,197X_4 \text{ Kurgan region} - 0,087$$

$$Y_5 = 0,834X_7 \text{ Sverdlovsk region} + 0,188X_9 \text{ Sverdlovsk region}$$

$$Y_6 = 0,808X_7 \text{ Sverdlovsk region}$$

## 4 Conclusion

The study showed that the relationship between the logistics infrastructure of the Ural Federal District and the economic indicators of the district and the country can be expressed as a linear multiple regression model. The reliability of the obtained models is due to both the value of the adjusted R-squared (>70%), and the performed verification to identify deviations from standard assumptions.

The results indicate a significant impact of transport logistics infrastructure facilities on the studied economic indicators. Dependent variables of the Russian Federation - "Gross domestic product, bil. rub." and "Investments in fixed assets, bil. rub." - most closely related to the passenger traffic at Koltsovo airport. A 1% increase in this value will lead to an increase in economic indicators by 0.69 and 0.8 percentage points, respectively. An 1% increase in the number of transport enterprises in the Tyumen region will lead to an

increase in the revenues of the consolidated budgets of the Russian Federation by 0.65 percentage points.

The passenger traffic at Koltsovo airport have the greatest impact on economic indicators of the Ural Federal District. An increase in this value by 1% will lead to an increase in economic indicators by 0.778, 0.835, and 0.807 percentage points.

Thus, the development of the airport infrastructure of Yekaterinburg, as well as the improvement of operation conditions of transport enterprises will have the greatest impact on the value of the economic indicators of the Russian Federation and the Ural Federal District. The results correlate well with the challenges of the Strategy for the Socio-Economic Development of the District.

The discussed model can be used to form a logistics infrastructure in the region [5-8].

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