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ECONOMETRIC MODEL OF OPERATING JOINT-STOCK COMPANY «O'ZBEKISTON TEMIR YO'LLARI» AND POSSIBLE DIRECTIONS OF DEVELOPMENT

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Abstract: *The article analyzes the current state and future development of railway transport, presents an econometric model of the development of investment activity in the context of strategic changes in the transport system. The article is devoted to the substantiation of approaches to the development of an algorithm for assessing the impact of railway transport on the country's economic security. The proposals on the use of econometric modeling to develop a simulation model of the railway system are justified. The stages of the implementation of the economic feasibility of management decisions in the railway system are considered.*

Therefore, the priority tasks of the structural reform of the industry is to create conditions for the development of competition in the field of transportation of goods and passengers, repair of rolling stock, as well as increasing investment attractiveness. As a result of the implementation of the planned infrastructure projects, there is an acute problem of a lack of investment funds, and even escalates due to the growing physical depreciation of fixed assets. Currently, there is a big gap between the level of investment existing in the industry and the level necessary to ensure sustainable development.

Key words: *development, innovation and investment activity, econometric model, railway transport*

Introduction

The transport system plays a key role in the socio-economic development of the country, being an integral part of the production and social infrastructure, it ensures the territorial integrity and national security of the state. The state and development of the economy of Uzbekistan, primarily the sphere of material production, as well as the country's integration into the world economic system, depend on the stable operation of the transport system. The availability of convenient transportation networks that allow for the rapid and efficient promotion of goods to domestic and world markets, is one of the main conditions for providing investments worldwide.

At present, domestic transport is developing in a situation where there is a tendency to revitalize and restore the real sector of the economy, the situation in the financial and credit sectors is gradually normalizing, demand for transport services is increasing, important structural transformations are being implemented, legal, economic and administrative mechanisms governing transport are being improved activity.

At the same time, it is safe to say that the transport system has the potential to support the development of the economy and the growth of well-being of the population.

Literature review

In foreign and domestic publications on freight transport carriages most research focuses on demand modeling, considering the elasticity of demand and boron in the

redistribution of goods between different types of transport. For example, T.V. Bjørner conducted an empirical analysis of call transport in Denmark using the cointegration vector regression system [1]. M. Kulshreshtha and V. Nag also used cointegration VAR-models in modeling demand for Indian rail freight transport [2].

R. Ramanathan used cointegration vector regressionny system in modeling and forecasting demand for passenger and freight transportation in India [3]. Their English counterparts Shujie Shen, Tony Fowkes, Tony Whiteing and Daniel Johnson investigated in more detail the demand for trucking in the UK using six econometric models [4]. In Russia E.E. Kolchinskaya based on statistics for Russian regions using regression models of panel data the relationship between the level of development of transport in the region and the dynamics of industrial production in it was studied [5]. By information available to the authors, publications in Russian language on this subject are absent. Moreover, none of the previous studies evaluated the effectiveness of forecasting alternative models.

Theory

The scientific theory is formulated by the fact that at the moment it is necessary to study the railway industry of the Republic of Uzbekistan from the inside. After the studies, it will be possible to make recommendations on the development of investment activities of the industry and the country.

Methodology

The methodology for studying the country's railway system is carried out by the econometric modeling of the railway network activity in the country is one of the areas of analysis and further development of the sector. The econometric models allow not only quantitative analysis of the rail network development, but also the determination of the composition of the factors affecting it and the contribution of each factor.

Econometric modeling of railroad industry development indicators in the country will allow quantitative determination of the factors affecting the profitability of the sector and making optimal decisions on their development.

In determining the development of the railway network of the Republic of Uzbekistan, we choose the following factors:

- Resulting factor - gross income of JSC «O'zbekiston temir yo'llari», mln. sum, (Y);

- as influencing factors - volume of investments into fixed capital in OJSC "O'zbekiston temir yo'llari", bln. sum (X_1), number of employees of JSC "O'zbekiston temir yo'llari", (X_2), freight turnover of JSC "O'zbekiston temir yo'llari", mln. tonnes-km (X_3) and passenger turnover of JSC "O'zbekiston temir yo'llari", mln. passenger-km (X_4).

First of all, before establishing a multidimensional econometric model of gross income in JSC "O'zbekiston temir yo'llari", it is necessary to determine the correlation between the factors included in this model. For this, the correlation coefficients between the factors are calculated. When calculating the correlation coefficients, the following formula is used:

$$r_{xy} = \frac{\overline{xy} - \overline{x} \cdot \overline{y}}{\sigma_x \cdot \sigma_y}$$

where σ_x and σ_y - is the mean square deviation of the factors, respectively.

Data

The logarithmic values of these factors are calculated because the factors involved in the multidimensional econometric model are different in units, i.e. the gross income of JSC

"O'zbekiston temir yo'llari", bln. soums (lnY), the volume of investments into fixed capital in JSC «O'zbekiston temir yo'llari», mln.sum (lnX_1), number of employees of JSC «O'zbekiston temir yo'llari», number of employees (lnX_2), freight turnover of JSC «O'zbekiston temir yo'llari», mln. tonnes-km (lnX_3) and passenger turnover of JSC «O'zbekiston temir yo'llari», mln. passenger-km (lnX_4).

We then perform a correlation analysis to determine the links between these factors

Using the Excel spreadsheet, we calculate the correlation coefficients among the factors (Table 1).

Table 1

Matrix of correlation coefficients calculated between gross income of the railway network of the Republic of Uzbekistan and factors affecting it

Indicators	ln(Y)	ln(X_1)	ln(X_2)	ln(X_3)	ln(X_4)
ln(Y) Gross income of JSC «O'zbekiston temir yo'llari», mln. Soums	1				
ln(X_1) The volume of investments into fixed capital in JSC «O'zbekiston temir yo'llari», mln.sum	0,9388	1			
ln(X_2) Number of employees of JSC «O'zbekiston temir yo'llari», number of employees	0,9511	0,9315	1		
ln(X_3) Freight turnover of JSC «O'zbekiston temir yo'llari», mln. tonnes-km	0,4688	0,6329	0,5108	1	
ln(X_4) Passenger turnover of JSC «O'zbekiston temir yo'llari», mln. passenger-km	0,9167	0,9558	0,9175	0,6324	1

Hence, the correlation coefficients between the factors, that is, the values of the individual correlation coefficients, are as follows:

$$r_{ln\,y\,ln\,x_1} = 0{,}9388,\ r_{ln\,y\,ln\,x_2} = 0{,}9511,\ r_{ln\,y\,ln\,x_3} = 0{,}4688,\ r_{ln\,y\,ln\,x_4} = 0{,}9167.$$

The correlation coefficients among the factors indicate that there is a strong correlation between the gross income of JSC «O'zbekiston temir yo'llari» (lnY) and the volume of investment in fixed assets of JSC «O'zbekiston temir yo'llari» (lnX_1). There is a strong correlation between the gross income of JSC «O'zbekiston temir yo'llari» (lnY) and the number of employees (lnX_2) operating in JSC «O'zbekiston temir yo'llari». There is a reasonable correlation between the gross income of JSC «O'zbekiston temir yo'llari» (lnY) and the freight turnover of JSC «O'zbekiston temir yo'llari» (lnX_3). There is a strong correlation between the gross income of JSC «O'zbekiston temir yo'llari» (lnY) and the passenger turnover of JSC «O'zbekiston temir yo'llari» (lnX_4).

It is also important to note that there is a strong correlation between the pairwise correlations between the factors, that is, the multicollenality between the factors. This means that one of these factors should not be included in the econometric model to be drawn. This problem can be solved by constructing a multivariate econometric model of factors.

We will now build a multidimensional econometric model on the above-mentioned factors in terms of the gross income of JSC «O'zbekiston temir yo'llari» and the factors affecting it. It looks like this:

$$\hat{Y} = 24{,}943 + 0{,}342 \cdot ln\,X_1 + 2{,}955 \cdot ln\,X_2 - 1{,}642 \cdot ln\,X_3 + 0{,}414 \cdot ln\,X_4 \quad (1)$$

$R^2 = 0{,}9688; F_{\text{accjunt}} = 34{,}34.$

The coefficient of -24,943 in the model is influenced by the factors that are not taken into account, that is, if you ignore the above factors, the gross income of JSC «O'zbekiston temir yo'llari» is 24.943 million. It would be worth UZS 1 billion.

From this model, we can say that the volume of investments in fixed assets ($\ln X_1$) of JSC «O'zbekiston temir yo'llari» is about one million USD. As a result, the gross profit ($\ln Y$) of JSC «O'zbekiston temir yo'llari» increased by 0.342 mln. This could lead to an increase in the amount of money.

Increase of the number of employees ($\ln X_2$) of JSC «O'zbekiston temir yo'llari» on average by 1 unit, the gross profit of «O'zbekiston temir yo'llari» increased by 2.955 mln. This could lead to an increase in the amount of money. JSC «O'zbekiston temir yo'llari» freight turnover ($\ln X_3$) is on average 1 billion. tonnes / km, the gross profit ($\ln Y$) of JSC «O'zbekiston temir yo'llari» increased by 1.642 mln. This can lead to a decrease in the amount of JSC «O'zbekiston temir yo'llari» passenger turnover makes up 1 mln passenger-km, the gross profit ($\ln Y$) of O'zbekiston temir yo'llari is on average 0.414 million. sum. It can lead to an increase in the amount of

$R^2 = 0{,}9688$

The coefficient of determination indicates that 96.88% of JSC «O'zbekiston temir yo'llari» gross profit depends on the factors included in the multi-factor econometric model. The remaining 3.12% is influenced by unaccountable factors.

We investigate whether the constructed multivariate econometric model corresponds to the studied process or its statistical significance. Fisher's F-criteria is used for this.

Using Fisher's F-criterion, one can check the completeness of the model, that is, its compliance with the real economic process:

$$F_{\text{account}} = \frac{R^2(n-m-1)}{(1-R^2)m}$$

where n is the number of observations;

m - is the number of influencing factors in the model;

P - is a multivariate correlation coefficient.

The calculated Fisher criterion is compared to the value in the table. To find the Fisher coefficients in the table, it is necessary to define the row and column: $k_1 = n - m - 1$ and $k_2 = m$. If so, $F_{\text{account}} > F_{\text{table}}$ the structured econometric model is called statistically significant or adequate to the process under study. If so, $F_{\text{хисоб}} < F_{\text{жадвал}}$ the structured econometric model is said to be statistically insignificant or incompatible with the process under study. In this case, a non-linear econometric model is selected instead of a linear econometric model.

(1) for the model $k_1 = n - m - 1 = 14 - 4 - 1 = 9$ and $k_2 = 4$ we can see that the value of the table is 3.63. This means that $F_{\text{account}} = 34.34 > F_{\text{table}} = 3.63$.

Consequently, the structured econometric model is statistically significant, which directly determines the gross profit margin at Uzbekiston temir yollari. In addition, using this model, the gross profit of the railway network can be forecasted for future periods.

The reliability of each factor in the model should be tested using the Student's t-test, which is calculated using the following formula:

$$t_R = \frac{R\sqrt{n-k-1}}{1-R^2}$$

where, $n-k-1$ - the number of degrees of freedom;

t_R - Compares the value of the table;

$n-2$ - Distributed with degrees of freedom

$$t_{a_j} = \frac{a_i}{\sigma_{a_j}}$$

The reliability of the regression coefficients is evaluated on the basis of

The values of the Student's criterion calculated by the regression coefficients in the constructed (1) econometric model are as follows:

$t_{ln\,x_1} = 1{,}47 \quad prob = 0{,}1749; t_{ln\,x_2} = 1{,}85 \quad prob = 0{,}0966;$

$t_{ln\,x_3} = -1{,}36 \quad prob = 0{,}2067; t_{ln\,x4} = 0{,}43 \quad prob = 0{,}6772.$

To check the reliability of these computed parameters, we refer to the Student Distribution Table. If so, $t_{\text{account}} > t_{\text{table}}$ then the regression coefficients are called trust, otherwise they are called unreliable. The 95% accuracy on the student's distribution schedule is t_{table} = 1,3502. All factors in the econometric model that are compiled (1) meet the requirement (except for passenger turnover).

We use the Darbin-Watson (DW) criterion to check for the autocorrelation in the residuals of the causal factor in the model (1):

$$DW = \frac{\sum_{t=2}^{T}(\varepsilon_t - \varepsilon_{t-1})^2}{\sum_{t=1}^{T}\varepsilon_t^2}$$

If there is no autocorrelation in the residuals of the causative factor, $DW = 2$ the positive autocorrelation is zero, and the negative autocorrelation is 4.

If there is no autocorrelation in the residuals of the causal factor, then the value of the calculated DW is around 2. In our example, the calculated DW criterion is 2,223. This indicates that there is an autocorrelation of the residual factor factor.

Consequently, as a result of the multicollinearity identified in the correlation analysis above, we did not have an adequate multivariate econometric model. As mentioned earlier, we subtract the multivariate factors from the multivariate econometric model with multicollinearity between pairwise correlation coefficients.

As can be seen in Table 1, there is a strong correlation between the volume of investments in fixed assets (lnX_1) and the number of employees (lnX_2) operating in JSC «O'zbekiston temir yo'llari» (0.9315). A strong correlation (0.9558) was also found between the number of employees (lnX_2) operating at JSC «O'zbekiston temir yo'llari» and the passenger turnover of JSC «O'zbekiston temir yo'llari» (lnX_4).

To eliminate multicollinearity, we consider the correlation factor of each of the factors that are strongly interconnected, the density of the gross income (lnY) of JSC «O'zbekiston temir yo'llari» and exclude this factor from the multivariate econometric model, if the strongest correlation is identified.

According to Table 1, the passenger turnover of JSC «O'zbekiston temir yo'llari» (lnX_4) has the largest multicollinearity (simultaneously the volume of investments in fixed capital in the rail network (lnX1) and the number of railroad workers (lnX_2). bound to (0.9558 and 0.9175, respectively) and exclude this factor from the multivariate econometric model. Again we calculate the correlation coefficients among the factors. The results are presented in Table 2.

Empirical results

Table 2

Matrix of correlation coefficients, calculated between gross income of JSC «O'zbekiston temir yo'llari» and factors affecting it

Indicators	ln(Y)	ln(X_1)	ln(X_2)	ln(X_3)
ln(Y) Gross income of JSC «O'zbekiston temir yo'llari», mln. Soums	1			
ln(X_1) The volume of investments into fixed capital in JSC «O'zbekiston temir yo'llari», mln.sum	0,938821	1		
ln(X_2) Number of employees of JSC «O'zbekiston temir yo'llari», number of employees	0,951076	0,931476	1	
ln(X_3) Freight turnover of JSC «O'zbekiston temir yo'llari», mln. tonnes-km	0,468756	0,632928	0,510775	1

The removal of the neglected rail network's passenger turnover factor (lnX4) from the multivariate econometric model, while maintaining linkage density on the one hand, resulted in the elimination of multicollinearity among the influencing factors on the other. We will create a new multivariate econometric model. And it looks like this:

$$\hat{Y} = -27{,}935 + 0{,}403 \cdot ln\, X_1 + 3{,}162 \cdot ln\, X_2 - 1{,}535 \cdot ln\, X_3 \qquad (2)$$

$R^2 = 0{,}9372$; $F_{\text{хисоб}} = 49{,}784$; $t_{ln\, x_1} = 2{,}269 \quad \text{prob} = 0{,}0466$;

$t_{ln\, x_2} = 2{,}172 \quad \text{prob} = 0{,}0500$, $t_{ln\, x_3} = -1{,}356 \quad \text{prob} = 0{,}205$,

The obtained (2) multivariate econometric model (1) is more statistically significant than the model, and the model parameters are reliable.

(2) Estimated and true values of gross income of JSC «O'zbekiston temir yo'llari» based on the model are shown in Figure 1 below.

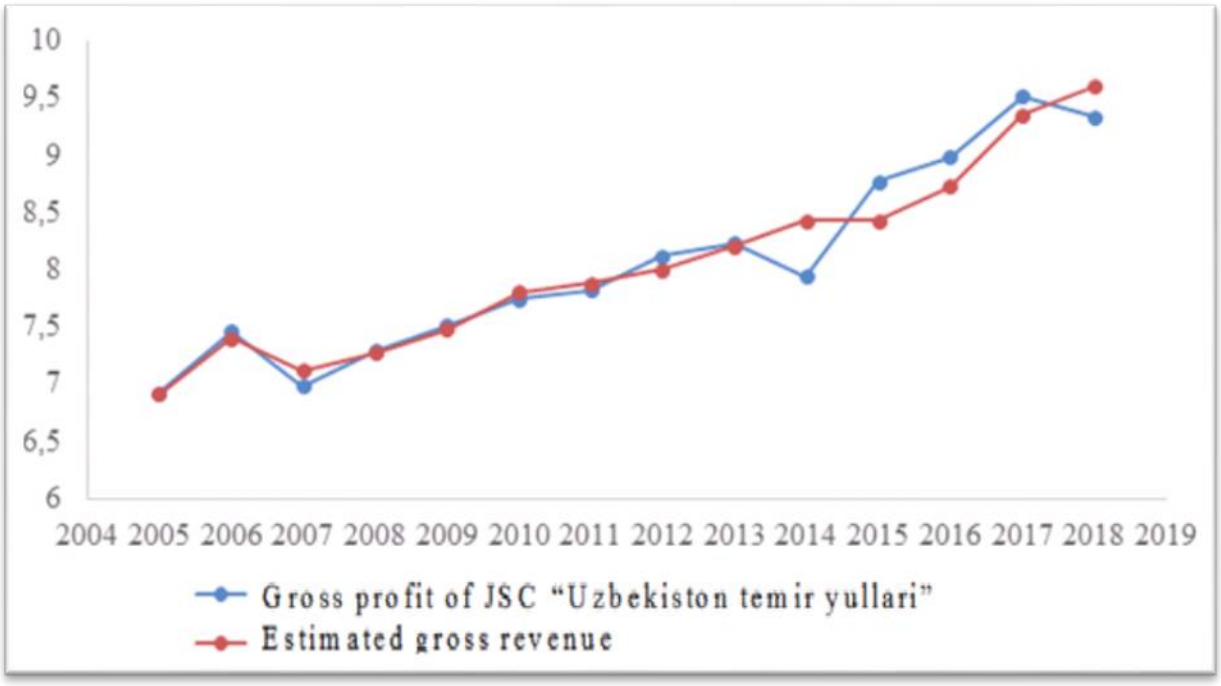

Figure 1. Schedule of estimated and actual values of gross income of JSC «O'zbekiston temir yo'llari»

As can be seen from Figure 1, the estimated and actual values of gross income of JSC «O'zbekiston temir yo'llari» for 2005-2018 are almost the same. That is, the differences between them are not so great.

Consequently, based on model (2), it is possible to forecast the gross profit of JSC "O'zbekiston temir yo'llari" for future periods.

For this purpose, first of all, the volume of investments in fixed assets ($\ln X_1$) of JSC «O'zbekiston temir yo'llari», which are the factors affecting the gross profit of JSC «O'zbekiston temir yo'llari»,We construct trend models on time factor (t) of the number of employees ($\ln X_2$) and freight turnover ($\ln X_3$) of JSC «O'zbekiston temir yo'llari».

Trends model for the volume of investments in fixed assets of JSC «O'zbekiston temir yo'llari»:

$$ln\, x_1 = 11{,}5191 + 0{,}279 \cdot t$$
$$(0{,}15) \quad (0{,}018) \qquad (3)$$
$$R^2 = 0{,}9525;\ F_{\text{хисоб}} = 240{,}84;\ t_{ln\,x1} = 15{,}52$$

Trends model for the number of employees of JSC "O'zbekiston temir yo'llari":

$$ln\, x_2 = 10{,}931 - 0{,}029 \cdot t$$
$$(0{,}023) \quad (0{,}003) \qquad (4)$$
$$R^2 = 0{,}9505;\ F_{\text{хисоб}} = 112{,}34;\ t_{ln\,x2} = 10{,}599$$

JSC «O'zbekiston temir yo'llari» mastered investments into fixed capital, mln. (lnX1), number of employees of JSC «O'zbekiston temir yo'llari», number ($\ln X_2$), freight turnover of JSC «O'zbekiston temir yo'llari», bln. The predicted results of calculations for ton-km ($\ln X_3$) trend models are shown in Table 3 below (logarithmic values are given by actual values).

Table 3

Dynamics of main indicators of gross income of JSC «O'zbekiston temir yo'llari» for 2005-2018 and forecast indicators for 2019-2023

Years	Gross income of JSC «O'zbekiston temir yo'llari», bln. soums	The volume of investments into fixed capital in JSC «O'zbekiston temir yo'llari», mln.sum	Number of employees of JSC «O'zbekiston temir yo'llari», number of employees	Freight turnover of JSC «O'zbekiston temir yo'llari», bln. tonnes-km
2005	1016,44	73835,00	59874	18,093
2006	1733,71	297252,30	60226	19,281
2007	1074,54	213151,10	60686	21,593
2008	1459,34	324261,70	62977	23,432
2009	1827,56	408369,60	66253	24,238
2010	2298,50	658300,90	66429	22,282
2011	2497,53	784415,60	66792	22,482
2012	3365,75	874473,50	68774	22,686
2013	3743,12	1088830,60	71744	22,918
2014	2799,94	1755700,00	72284	22,931
2015	6449,25	1460022,80	74136	22,935
2016	8015,83	2660582,30	75393	22,937
2017	13557,83	3843788,50	87684	22,940
2018	11320,41	5142754,30	91440	22,942
2019	12653,05	6298864,90	87053	24,193
2020	15252,91	8299186,04	89661	24,471
2021	18386,96	10934746,18	92346	24,753
2022	22164,97	14407277,23	95112	25,038
2023	26719,27	18982574,79	97960	25,326

Using the data in Table 3, we formulate the schedule for the changes in the forecast period under the factors affecting the gross profit of JSC «O'zbekiston temir yo'llari». This graph is shown in Figure 2.

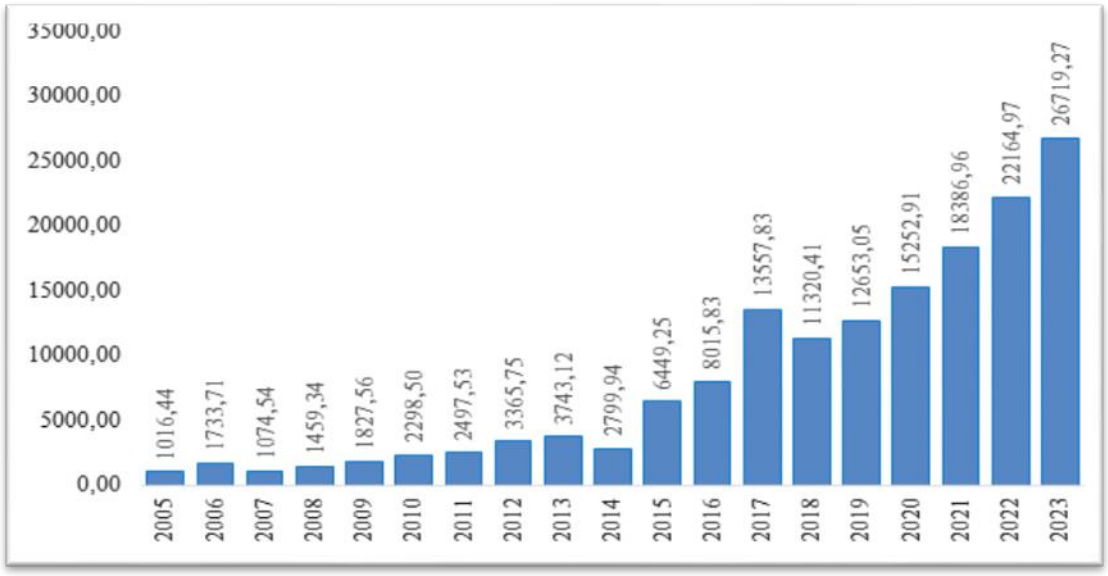

Figure 2. Dynamics of gross profit of JSC «O'zbekiston temir yo'llari» for 2005-2018 and forecast indicators for 2019-2023, mln. soum

As you can see from the above picture, gross profit of JSC «O'zbekiston temir yo'llari» in 2018 decreased by 16.5% compared to 2017. According to our forecasts, if the major part of the investments attracted is focused not on social infrastructure, but on the quality of services and the production and sale of products, it will be possible to increase revenue by 2020.

Figure 3 shows the dynamics of investment in fixed assets of JSC «O'zbekiston temir yo'llari» in 2005-2018 and forecast values for 2019-2023.

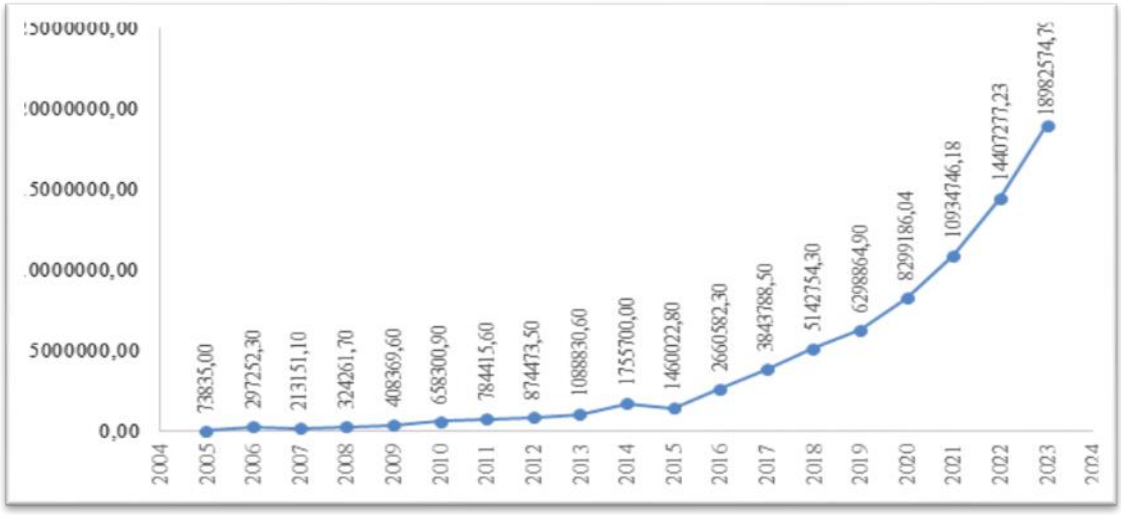

Figure 3. Dynamics of investment in fixed assets of JSC «O'zbekiston temir yo'llari» in 2005-2018 and forecast values for 2019-2023 mln. soum

Investment in fixed assets of JSC «O'zbekiston temir yo'llari» decreased in 2015 compared to 2014. However, recent reforms in the industry and attempts to introduce new technologies have contributed to increased investment. At the same time, according to the available data, by 2023 the volume of investments can reach 1 898 274.79 million sums.

Figure 4 below shows the dynamics of the number of employees in the JSC «O'zbekiston temir yo'llari» in 2005-2018 and forecast values for 2019-2023.

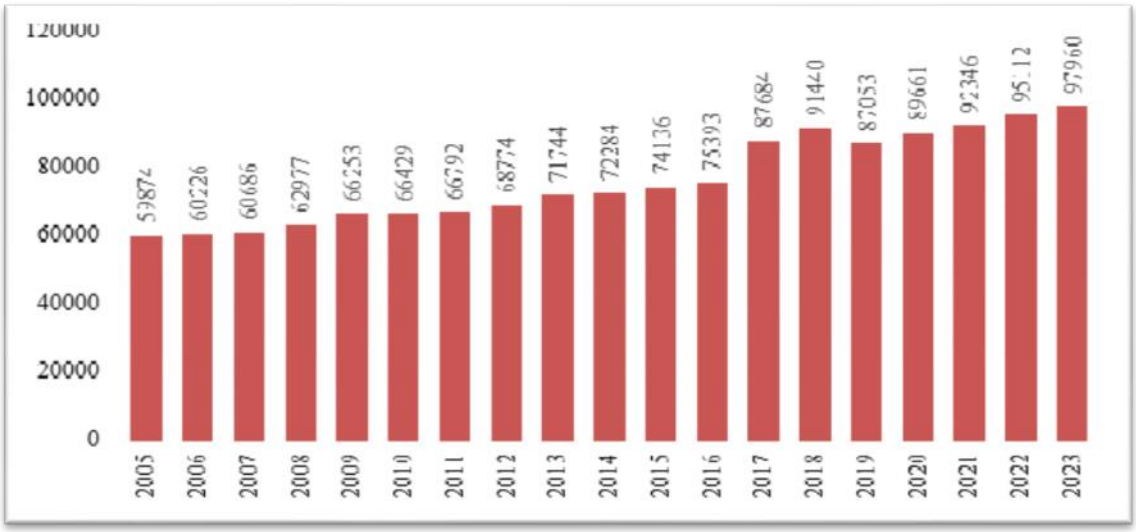

Figure 4. Dynamics of the number of employees of JSC «O'zbekiston temir yo'llari» for 2005-2018 and projected values for 2019-2023

As for the projected figures of the number of employees of JSC «O'zbekiston temir yo'llari», it can be seen from the figure that by 2023 the total number of employees employed in the railway system will reach 98,000.

Figure 5 shows the dynamics of freight turnover of JSC «O'zbekiston temir yo'llari» in 2005-2018 and forecast values for 2019-2023.

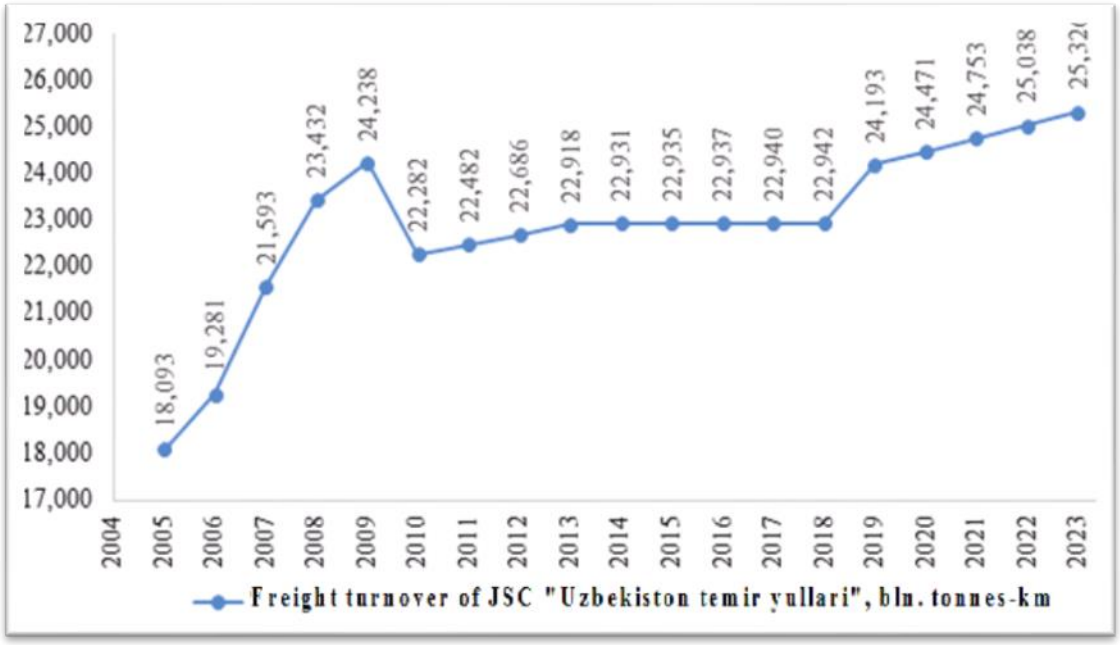

Figure 5. Dynamics of freight turnover of JSC «O'zbekiston temir yo'llari» in 2005-2018 and forecast values for 2019-2023, bln. tonnes.km

JSC «O'zbekiston temir yo'llari» increased volume of cargo turnover by 22 bln in 2010-2018 tons per km. However, the increase in investment in the sector to raise profits can also have a positive impact on the volume of freight turnover. This means that by 2022, the volume of freight turnover by rail will increase to 25 billion. tons per km.

Conclusion

The presence of infrastructural restrictions on the economic growth of regions has been established. At the same time, the mismatch between the needs of the railways in investments with the possibility of channeling their own funds and attracting capital from outside investors was proved. In such circumstances, it is necessary to justify rational priorities in investing based on the full reflection of the attractiveness of railway projects. However, the well-known, widely used principles for evaluating the effectiveness of investments do not always allow us to present the full effect of the implementation of railway transport.

The objective need for state support in the implementation of large railway projects requires the selection of rational and effective forms and mechanisms. It has been established that along with the forms of state support used (direct participation in financing, payment of interest on attracted commercial loans, provision of tax benefits and state guarantees for attracting private capital) for large railway projects, the mechanism of concession agreements is expedient.

In order to actively attract outside investors into public-private partnerships, a general comprehensive assessment of the results of projects is needed, which allows them to compare their investment attractiveness.

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