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ECONOMETRIC ANALYSIS OF INVESTMENT IN FIXED ASSETS IN THE CHELYABINSK REGION

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The article presents the results of an econometric analysis of investments in fixed assets in the Chelyabinsk region. Starting from theoretical and methodological approaches, investments in fixed assets are considered as an indicator of investment activity in the implementation of investment policy, as well as a reflection of government regulation measures. Data sets were formed on the basis of official statistical information. Significant variables were identified, and a preliminary specification of the models was carried out. As a result of econometric modelling, regression models are obtained. A forecast was built, the result was compared with real data.

Keywords: econometric analysis; correlation; regression; econometric model.

Introduction

Fixed assets investments are the basis for economic and social transformation. The relevance of econometric analysis of investments in fixed assets is due to the need to assess the volume of investments in fixed assets as a result of investment activities of economic entities in the region in the implementation of investment policy.

All stages of econometric analysis make it possible to reveal the essence of investments in fixed assets, to determine the relationship with socio-economic indicators, to build econometric models for prediction and making managerial decisions in conditions of strategic development, based on the influence of explanatory variables. The ultimate goal of the study is to build econometric models of the influence of potentials and risks (selected from the number of socio-economic indicators), as well as measures of state regulation, on investments in fixed assets in the Chelyabinsk region.

Based on theoretical and methodological approaches, investments in fixed assets are considered in direct connection with investment activities and investment policy. In the structure of the state system, state policy underlies all conceptual transformations [1]. Relying on this, two approaches are used to form data sets:

1) investments in fixed assets as an indicator of investment activity in the implementation of investment policy (result: building a model of the influence of the region's potentials and risks on investments in fixed assets);

2) investments in fixed assets as a reflection of government regulation measures (result: building models of the influence of government regulation indicators on investments in fixed assets).

To build an econometric model, into the first data set (data set No. 1) were selected indicators relying on the role of investment policy in the development of the socio-economic system. The indicators were selected taking into account the characteristics of the region's potential opportunities and investment risks. We considered the data for the Chelyabinsk region for 20 periods (2000 – 2019) [2, 3]. Primarily, 12 indicators were selected for analysis.

The following indicators were selected as explanatory variables characterizing labor, production, consumer, financial and innovation potentials: X_1 is GRP per capita, rubles; X_2 is the average annual number of people employed in the economy, thousand people; X_3 is the actual final consumption of households per capita, at current market prices, rubles; X_4 is the balanced financial result (profit minus loss) of the organizations' activities, million rubles; X_5 is the volume of innovative goods, works, services, as a percentage of the total volume of goods shipped, works performed, services. To determine the impact of risks, indicators of economic, financial, social, environmental and criminal risks were selected: X_6 are consumer price indices, December to December of the previous year, in per cent; X_7 are the numbers unemployed, according to sample surveys of the labor force, thousand people; X_8 is the degree of depreciation of fixed capitals, at the end of the year, in per cent; X_9 is the specific weight of unprofitable organizations, as a percentage of the total number of organizations; X_{10} is the share of the population with monetary incomes below the subsistence minimum established, as a percentage of the total population of the subject; X_{11} is the volume of emissions of harmful (polluting) substances into the atmospheric air from stationary sources located in the region, thousand tons; X_{12} is crime rate, thousand units per 100 thousand population. The indicator «investment in fixed assets per capita, rubles» was taken as an effective feature (Y).

The hypothesis of the normal distribution of variables was tested, Spearman's correlation matrix was constructed, as a result of assessing the significance at the set level of 0.05, insignificant variables were determined. As a result of identifying multicollinearity, variables that have a lower correlation with the effective feature are excluded. A preliminary analysis of the type of relationship between Y and the selected explanatory variables showed the possibility of constructing a linear model. As a result of stepwise regression analysis, a linear regression model Y on X_1, X_{10} was obtained. When checking the quality of the linear model, a high approximation error was obtained ($A = 17.97\%$), which led to the refinement of the model specification and the construction of a power regression. Table 1 presents estimates of the significance of the obtained models.

Regression models reflect the impact on investment in fixed assets per capita of the indicator of economic potential is GRP per capita, and social risk is the share of the population with money incomes below the minimum subsistence level established in the Chelyabinsk region. The power-law model is of a higher quality. In accordance with the model obtained, with an increase in GRP per capita by 1%, investments in fixed assets increase by 0.74%. With an increase in the share of the population with money incomes below the subsistence level established in the Chelyabinsk region, by 1%, investments in fixed assets per capita decrease by 0.59%.

Further, for consideration of the impact on investment in fixed assets of a set of government regulation measures in order to stabilize economic growth (based on the approach of government regulation of investment demand, which plays a decisive role in the cyclical nature of economic processes), indicators were selected for modelling that characterize taxes, government spending, and lending (data set No. 2): X_1 is tax receipts,

Table 1

Comparison of the estimates of the significance of the obtained regression models

Criteria	Linear regression $Y = 28273.296 + 0.134X_1 - 900.498X_{10}$	Power regression $Y = 21.0291{X_1}^{0.7446}{X_{10}}^{-0.5863}$
$F_{obs}(F_{cr})$	98.9 (3.59)	158.67 (3.59)
R^2	0.92	0.95
S_e	7152.7	5733.3
A	17.97	9.22
Equation estimate	significant ($\alpha = 0{,}05$)	significant ($\alpha = 0.05$)
Regression coefficients estimate	b_0, b_1, b_2 are significant ($\alpha = 0.05$)	b_0, b_1, b_2 are significant ($\alpha = 0.05$)

million rubles; X_2 are expenses of the consolidated budget of the Chelyabinsk region, million rubles; X_3 is debt on loans in rubles provided by credit institutions to legal entities (based on the location of borrowers; at the beginning of the year), million rubles.

As an effective feature (Y), the indicator is taken the investments in fixed assets, in actual prices, million rubles. We considered the data for the Chelyabinsk region for 14 periods (2006 – 2019) [3]. Based on the selected statistical data, after checking the significance of the paired correlation coefficients and checking for multicollinearity, a regression model of the influence of the results of government regulation on the volume of investment in fixed assets is built. On account of the Shapiro–Wilk test, all variables have a normal distribution. After constructing the pairwise Pearson correlation and checking the significance of the paired correlation coefficients, explanatory variables are determined that have a strong correlation with each other. As a result, the variable X_2 was selected for modelling, which has the highest connection with Y and the strong connection with other explanatory variables. As a result of the model specification, linear and power regression models are built. The results of assessing the quality and significance of the obtained models are presented in Table 2.

Table 2

Quality and significant rating of the resulting models

Criteria	Linear regression $Y = 32722.826 + 1.168 \cdot X_2$	Power regression $\mathrm{Y} = 10.5717 \cdot {\mathrm{X}_2}^{0.83}Y$
$F_{obs}(F_{cr})$	117.7	118.8
R^2	0.9075	0.9082
S_e	16853.6	16786.5
A	6.9	6.6
Equation estimate	significant ($\alpha = 0.05$)	significant ($\alpha = 0.05$)
Regression coefficients estimate	b_0 is not significant b_1 is significant ($\alpha = 0.05$)	b_0, b_1 are significant ($\alpha = 0.05$)

Based on the assessment of the quality of the obtained models, a power-law model is used for prediction. A point and interval prediction of investments in fixed assets was

constructed, provided by the condition that the average growth rate of expenses of the consolidated budget of the Chelyabinsk region for the previous periods (2006 – 2019) is maintained: $X_2 = 241007.4$ million rubles.

The point prediction for 2020 was:

Y = $10.5717 \cdot 241007.4^{0.83} = 309436.3$ million rubles.

The interval prediction is based on the reliability $\gamma = 0.95$.

To calculate the standard error of the prediction and the bounds of the corresponding confidence interval, the corresponding formulas were used [4, 5]:

$$m_{\hat{y}p} = S_e \cdot \sqrt{1 + \frac{1}{n} + \frac{(x_p - \overline{x})^2}{n \cdot \sigma_x^2}},$$

where S_e is the standard error of regression,

$$\hat{y}_{p\ min} = \hat{y}_p - \ t_\alpha \cdot m_{\hat{y}p}\ ,$$

$$\hat{y}_{p\ max} = \hat{y}_p + \ t_\alpha \cdot m_{\hat{y}p}\ .$$

The following results were obtained:

$$m_{\hat{y}p} = 16786.5\sqrt{1 + \frac{1}{14} + \frac{(241007.4 - 135878)^2}{14 \cdot 1750557899}} = 20712.04,$$

$$y_{pmin} \ = 309436.3 - 2.1788 \cdot 20712.04 = \ 264308.62,$$

$$y_{pmax} \ = \ 309436.3 + 2.1788 \cdot 20712.04 = 354563.92.$$

The prediction accuracy, calculated as the ratio $\frac{y_{pmax}}{y_{pmin}} = D = 1.34 < 2$ was less than 2 times, which indicates a sufficient prediction accuracy. The real indicator of investments in fixed assets in the Chelyabinsk region for 2020, according to the first annual estimate, amounted to 322198.3 million rubles [6] and exceeded the obtained prediction by 4.1% according to the point estimate of the power model. The result was included in the interval prediction, which indicates the adequacy of the resulting econometric model.

In Russia as a whole, in 2020, investments in fixed assets, according to the first annual estimate, amounted to 20118.4 billion rubles, or 98.6% of the previous year in comparable prices [6]. The dynamics of the indicator for the constituent entities of the Russian Federation (RF) is ambiguous. The Chelyabinsk Region ranks 16th among the constituent entities of the Russian Federation in terms of investments in fixed assets with a positive trend of 100.1% in comparable prices to the previous year.

The impact of the coronavirus pandemic in 2020 on the volume of investment in fixed assets in the Chelyabinsk region was smoothed by account of the continuation of investment projects in manufacturing industries and the completion of the largest investment project for the extraction and processing of porphyry copper ores in the region. The consequences of the pandemic continue, which is reflected in the dynamics of the indicator of investment in fixed assets in 2021 [6,7]. The approaches to the analysis of investments in fixed assets considered in the article make it possible to assess the results of investment policy through

socio-economic indicators and measures of state regulation, which is especially present-day during a pandemic.

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ЭКОНОМЕТРИЧЕСКИЙ АНАЛИЗ ИНВЕСТИЦИЙ В ОСНОВНОЙ КАПИТАЛ В ЧЕЛЯБИНСКОЙ ОБЛАСТИ

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В статье представлены результаты эконометрического анализа инвестиций в основной капитал в Челябинской области. Исходя из теоретических и методологических подходов, инвестиции в основной капитал рассматриваются как индикатор инвестиционной деятельности при реализации инвестиционной политики, а также как отражение мер государственного регулирования. На основании официальной статистической информации сформированы наборы данных. Определены значимые переменные, проведена предварительная спецификация моделей. В результате эконометрического моделирования получены регрессионные модели. Построен прогноз, результат сопоставлен с реальными данными.

Ключевые слова: эконометрический анализ; корреляция; регрессия;, эконометрическая модель.

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