Modeling the process of attracting foreign investment in the Russian economy

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Abstract. In the paper, on the basis of an assessment of the development of the Russian economy, the sectors most in need of an investment are identified, taking into account the depreciation rate of basic production assets. Depreciation of fixed assets reflects the demand for investment in order to modernize and reconstruct production. Based on the data of the Federal State Statistics Service of Russia, a rating of economic sectors in terms of the degree of depreciation of fixed assets at the end of the year by type of economic activity for 2013-2018 is built. In addition, the paper presents a model for predicting the inflow of foreign direct investment in Russia, developed using the classical approach to estimating linear regression criteria, which is based on the least squares method (OLS). In compiling this regression model, the applied software package for econometric modeling GRETL (GNU Regression, Econometrics and Time-series Library) was used to predict the inflow of foreign investment. Forecasting the inflow of foreign investment in the Russian Federation is aimed at solving the following tasks: to determine the most competent direction of investment policy and activity using forecast estimates, as well as to assess the country's investment attractiveness. However, a significant role in predicting this indicator is played by the determination of factors that have an impact on the future volume of foreign investment. In addition, the analysis of foreign investments, depending on the influence of various factors, can tell about those or other motives that guide foreign investors when investing their own capital.

1. Introduction

Forecasted inflow of foreign investment in the Russian Federation shall be aimed at solving the following tasks: on the one hand, to determine the most competent direction of investment policy and activity using forecast estimates, on the other hand, to show a scientifically based state of this indicator of the country in the future. At the same time, the due determining of factors which have an impact on the future volume of foreign investments, which our state will receive plays a significant role in forecasting of this indicator. In addition, the analysis of foreign investments, depending on the influence of various factors, can explain different motives, which guide foreign investors when investing their own capital.

In order to develop a model of forecasting the volume of inflows of foreign direct investment in Russia, we apply the classical approach to estimating linear regression criteria, which is based on the least squares method (OLS). The GRETL application software package for econometric modeling (GNU Regression, Econometrics and Time-series Library) will help to compile this regression model for predicting foreign investment inflows.

The following regressors have been selected to determine the dependence of foreign
investments: GDP growth rate (%); GDP per capita growth rate (%); the growth rate of the average monthly nominal accrued wages of employees of organizations in the whole economy (%); inflation growth rate, GDP deflator (%); cumulative investment in fixed assets with the participation of Russian investors (billion US dollars); accumulated investment in fixed assets with the participation of foreign investors (billion US dollars); gross domestic savings (% of GDP); the unemployment rate of the population (%); research and development costs (% of GDP); the growth rate of the population monetary incomes and expenditures (%); growth rate of organizations turnover (%).

The regression model was built using data from the Federal State Statistics Service of the Russian Federation and the World Bank and the Central Bank of the Russian Federation in the period of the years 1998–2018.

2. Materials and methods

The first stage of the analysis is the selection of factors which most significantly affect the size of FDI, for their subsequent inclusion in the equation of the regression model. This step was carried out based on the P-values of the coefficients of the variables. Thus, it was proposed to use seven variables (see Table 1).

| Variables                                                | Coefficient | St. error | t-statistics | P-value |
|----------------------------------------------------------|-------------|-----------|--------------|---------|
| const                                                    | -40.2752    | 14.4856   | -2.780       | 0.0214  **|
| GDP growth rate (X2)                                     | -36.6174    | 4.03276   | -9.080       | 7.94e-06 ***|
| GDP per capita growth rate (X1)                          | 40.5019     | 4.08051   | 9.926        | 3.81e-06 ***|
| research and development costs (X3)                      | 0.00458075  | 0.000823055 | 5.566      | 0.0003 ***|
| growth rate of the average monthly zar. wages of         | 0.305773    | 0.121193  | 2.513        | 0.0326 **|
| employees of organizations in the whole economy (X4)     |             |           |              |         |
| inflation rate (X5)                                      | 0.184801    | 0.0824055 | 2.304        | 0.0267 **|
| unemployment rate (X6)                                   | -5.17070    | 1.71755   | -3.026       | 0.0156 **|

The dependent variable is - the inflow of foreign direct investment (billion US dollars), factors - the growth rate of GDP per capita (%), the growth rate of GDP (%), the cost of research and development (% of GDP), the growth rate of the average monthly nominal wages of employees of organizations in the whole economy (%), inflation growth rate, or GDP deflator (%) and population unemployment rate (%). Let’s assume the probability of an erroneous deviation (rejection) of the hypothesis at a 5% significance level.

The next step in analyzing the influence of factors for the inflow of foreign direct investment is to assess the quality of the model obtained (see Table 2).
shows the proportion of variation of the resultant trait under the influence of the studied factors. Thus, about 94% of the variation of the dependent variable is taken into account in the constructed model and is due to the influence of six selected factors. The Standard Error parameter contains sample standard deviations for each coefficient of the regression equation, standard error factors. If the standard error is greater than the absolute value of the regression coefficient, this coefficient is insignificant. In the above model, the standard error is 5.154, which is lower than the regression coefficient (R-square = 0.937), therefore, the model constructed by this criterion is reliable.

All seven variables were tested for stationarity by the Dickey-Fuller extended test (ADF test) and KPSS to build a more accurate prediction, which resulted in the stationarity of the observed time series of all variables, i.e. there is no trend in these rows. The test proved the significance of all variables.

The next step is to check the feasibility of the prerequisites for constructing a regression model using the OLS for the presence of homoscedasticity, autocorrelation of residuals, and also checking the specification of the model. As a result of the analysis, the following test results were obtained (see Table 3).

Table 3. Feasibility of the prerequisites for building a regression model check using the OLS in the GRETL program.

| Test                                      | Null Hypothesis                        | p-value        |
|-------------------------------------------|----------------------------------------|----------------|
| Breusch-Pagan test for heteroscedasticity | no heteroscedasticity                  | 0.923741       |
| White's test for heteroscedasticity       | no heteroscedasticity                  | 0.711217       |
| Ramsey Test (RESET)                       | the specification is adequate          | 0.938316       |
| Durbin Watson Statistics                  | no autocorrelation of residuals        | 0.945857       |
| Lewing's Q-Statistics - Boxing            | no autocorrelation of residuals        | 0.059          |
| Test for normal error distribution       | errors are distributed according to the normal law | 0.544358 |

The key prerequisite for constructing the OLS model is the condition of homoscedasticity. The tests of Breusch-Pagan and White proved the presence of homoscedasticity, since the calculated p-value (0.924 and 0.711, respectively) in each test turned out to be higher than the error probability, that is, the zero hypothesis of the absence of heteroscedasticity was accepted.

Let us carry out the Ramsey test (RESET), which is used in econometrics to test the functional form (specification) of the model. Since the p-value (0.938) is greater than the probability of error, the zero hypothesis on the adequacy of the specification is accepted, which indicates an acceptable functional form of the given model. The test proved the correct choice of the type of relationships and relations between the elements of the model, as well as the correct choice of significant variables and parameters.

An important prerequisite for building a qualitative OLS model is the independence of the values of random deviations from the values of deviations in all other observations, that is, the absence of residual autocorrelation. The absence of autocorrelation of residuals ensures the consistency and efficiency of estimates of the regression coefficients. Check for the presence of residual autocorrelation using the Durbin Watson and Ljung-Box tests. The calculated p-value in both tests (0.946 and 0.059, respectively) is greater than the probability of error, so autocorrelation of residuals
is absent in the model.

Analyzing the quality of the model, it is necessary to check a number of statistical hypotheses using the Fisher and Student criteria, which can be used in the case when the residuals are distributed according to the normal law. Let us analyze the normal distribution of residues: p-value = 0.544358 is more likely to be an error, that is, the residues are distributed according to the normal law.

3. Prediction of attracting foreign investment in the Russian economy based on economic and mathematical modeling

Thus, as a result of conducting checks on the feasibility of the OLS prerequisites when evaluating the reliability of a regression model, the author proved their feasibility and correctness of the model. The regression coefficients found on the basis of the system of normal equations are unbiased, efficient, and consistent, which enables to go to the regression equation and interpret its coefficients under the variables:

The coefficients of the regression equation can be interpreted as follows: with an increase in GDP growth per capita by 1%, the size of FDI increases by $40.5019 million, and with an increase in the growth rate of a country's GDP by 1% - decreases by 36.6174 million $. With an increase in research and development costs of $1 million, the inflow of FDI to Russia increases by 4.6 thousand dollars. With an increase in the average monthly nominal wage by 1%, the inflow of FDI increases by $305.8 thousand, and with an increase in the growth rate of inflation by 1% - by 189.8 thousand dollars. The growth of unemployment in Russia by 1% causes a decrease in FDI inflows into the country by $5.1707 million. Consequently, the analysis carried out according to the OLS revealed the main dependencies and patterns in the formation of the value of FDI inflows into the Russian economy, depending on the magnitude of significant factors.

At the final stage of work, it is necessary to build a forecast of FDI inflows into the Russian economy for the period from 2019 to 2021. According to the forecast in the GRETL program, the following values were obtained: in 2019, FDI inflows into Russia are forecasted at the level of $19.073 billion, in 2020 - $24.468 billion, in 2021 - $26.170 billion. Let us present the actual and forecast values of FDI inflows on the graph (see Figure 1).

![Figure 1. FDI inflow to Russia in 1998-2021, billion US dollars](image-url)

Thus, a gradual annual growth in the inflow of foreign capital into the Russian economy is predicted, indicating a recovery in investment activity after the investment pause in the Russian economy, which started in 2014.

Conclusion.
Consequently, the analysis carried out according to the OLS revealed the main dependencies and patterns in the formation of the value of FDI inflows into the Russian economy, depending on the magnitude of significant factors.

The result of the forecast of a positive inflow of FDI in Russia is confirmed by experts and analysts, including the head of the Russian Direct Investment Fund Kirill Dmitriev, the head of the FBS analytical department Elizaveta Belugina and analysts of large foreign banks (Deutsche Bank and Goldman Sachs). Large financial players are paying more and more attention to emerging markets; and Russia will become one of the priority areas for international capital during the forecasted periods. Among the factors that already have a positive effect on the “image” of the Russian economy in the eyes of investors are such as strengthening of the national currency, lower inflation and higher energy prices. However, it must be understood that Russia is still perceived by many investors as a country with a high country risk, so most of the funds that will be brought into the economy will still bear speculative character.

Competent and consistent investment policy of Russia, improving the country's investment climate, gradual stabilization of relations with the US and EU countries, reviving economic growth and consumer demand, successful implementation of a number of large investment projects, increasing the investment activity of private business will allow the country to solve the problem of attracting foreign investors in the Russian economy to ensure the gradual positive dynamics of the inflow of foreign investments and to embark on the path of sustainable Economic Growth.

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