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SIMULATION MODELING AS A TOOL FOR PROSPECTIVE DYNAMIC ASSESSMENT OF THE REGIONAL INVESTMENT CLIMATE

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Abstract: A high level of investment activity is a necessary factor for sustainable socio-economic development of regions due to their investment attractiveness. The relevance of the topic is due to the increasing competition of the constituent entities of the Russian Federation for attracting investments and the need to create a model that can predict investment inflows into the regional economy. The object of the research is the regional economic systems of the Russian Federation. The subject of the research is the factors that determine the investment attractiveness of the regions of the Russian Federation.

Keywords: Investments, Investment Attractiveness, Investment Activity, Regions of Russia.

INTRODUCTION

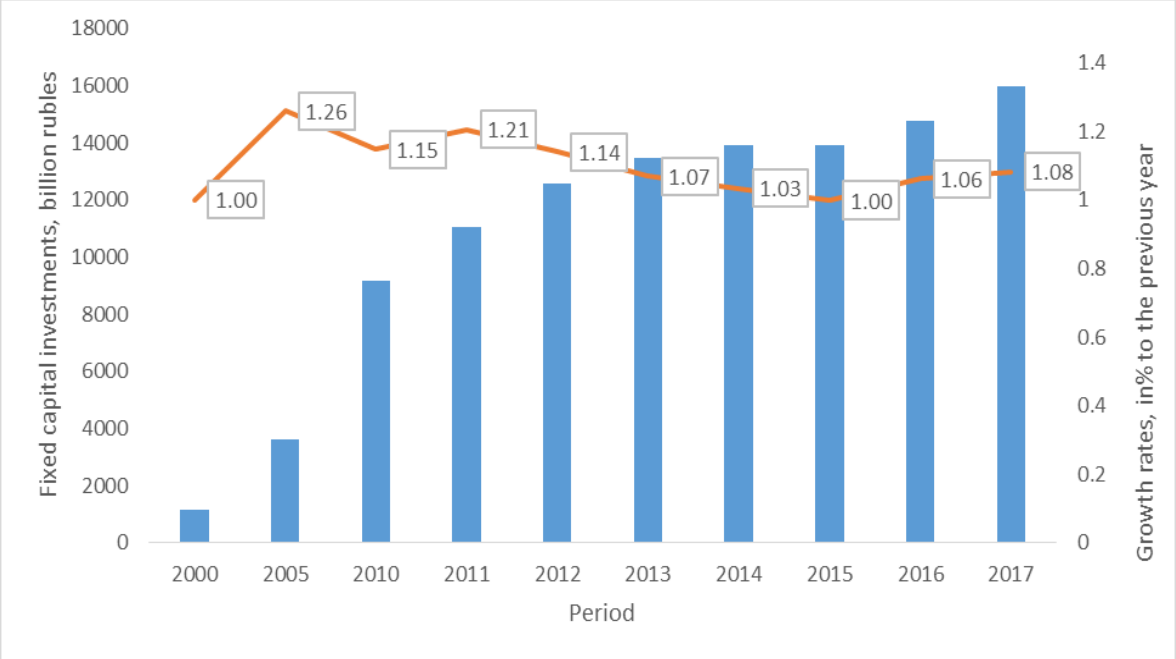
In an increasingly competitive environment, investment is becoming a scarce resource. Lack of investment in the economy of a country, region or an enterprise leads to a deterioration in socio-economic indicators, and obsolescence of infrastructure. When deciding on an investment, an investor conducts a thorough analysis of the object, including assessing the investment attractiveness of the region in which it plans to carry out its activities.(1-3) The concept of investment attractiveness is complex and is

characterized by versatility, and a large number of points of intersection with the economy, which determine the degree of influence on it. The level of attractiveness largely determines the well-being of each individual region of the Russian Federation. Investment attractiveness is formed as a result of analysis of the indicators characterising the socio-economic state of a region: territorial position, infrastructure development, legislative regulation of entrepreneurship, unemployment rate, etc. (6-10)

METHODS

As mentioned above, the investment attractiveness of individual territories or the country as a whole is one of the prerequisites for economic growth. The issue of raising capital has become especially relevant in the post-crisis period.(4-6). Today, despite the rich natural resource potential, the investment attractiveness of the Russian Federation remains at a relatively low level. This was not always the case; for example, according to Ernst and Young, in 2011 Russia was the country with the most favourable investment climate. Then the maximum growth of investments attracted to the country was registered. Compared to the previous year, it was more than 20%. However, economists associate this not only with the improvement of the investment climate, but also with the deterioration of the economic situation in other countries. Let us consider the dynamics of changes in investments in fixed assets of the Russian Federation. Investment in fixed assets is an indicator reflecting investments in buildings, structures, machinery and equipment. In fact, according to this indicator, one can draw a conclusion about the infrastructure potential of a country or region.

Figure 1. Dynamics of investments in fixed assets of the Russian Federation



Source: Compiled by the authors based on data from the Federal State Statistics Service. Access mode: https://www.gks.ru/.

The analysis of absolute indicators is insufficient for a correct interpretation of the state and dynamics of investments attracted to fixed capital. More detailed information can be obtained by comparing the values with the factor "Gross Domestic

Product". The ratio of investments in fixed assets to GDP is one of the key indicators of the country's economic development. It reflects the share of construction and technological renovation costs in the real sector of the economy. The calculation results are presented in table 1.

Table 1. Share of investment in fixed assets in gross domestic product

Period, year	2000	2005	2010	2014	2015	2016	2017	2018
Fixed capital investments, billion roubles	1165,2	3611,1	9152,1	13902,6	13897,2	14748,9	16027,3	17595,02
Gross Domestic Product, billion roubles	7305,6	21609,8	46308,5	79030,0	83087,4	85616,1	91843,2	104335,0
Share of investments in GDP,%	15,9%	16,7%	19,8%	17,6%	16,7%	17,2%	17,5%	16,9%

Source: Calculated by the authors based on data from the Federal State Statistics Service. Access mode: https://www.gks.ru/.

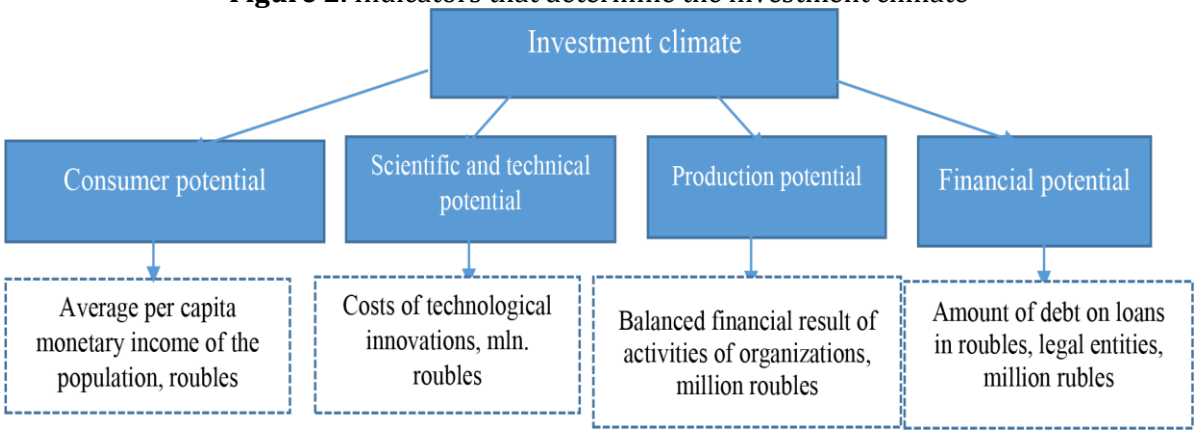
Based on the data obtained, it can be concluded that the nature of investment at the current moment is stagnant and fluctuates at the level of 17%. The ratio of investment in fixed assets to Russia's GDP fell from 17.5% in 2017 to 16.9% in 2018. As for the volume of investments in fixed assets in real terms, there is an increase of 4.3% over the same period in 2017, which corresponds to an increase of 17.6 trillion roubles. At the same time, real GDP growth was only 2.3%. Thus, with the previously indicated trend of decreasing the ratio of investments in fixed assets to GDP, the growth of investments exceeds the growth of GDP. Despite the seemingly sufficient elaboration of the algorithms for assessing the investment attractiveness of both national economies and regional systems, the task of finding methods that allow predicting the state of attractiveness of individual territories remains urgent.

The solution to this problem is very nontrivial. Regional investment attractiveness is a complex multifaceted system, consisting of a large number of its constituent elements. It is worth considering this process through the prism of studying the parameters and the nature of the development of its individual system-forming factors. As noted earlier, using the identified set of factors affecting the state of the investment climate, an attempt is made in this study to apply them within the framework of constructing an integrated index. In this connection, the definition of such common factors has become an important methodological element. In this study, the following areas are identified as the areas that have the greatest impact on the formation of the investment climate in the region: consumer potential, scientific and technical potential, production potential, and financial potential (Figure 2).

The factor reflecting the consumer potential was the average money income per capita. The size of the population income determines both the level of consumer demand and the most priority types of goods and services consumed by the population. The state of the scientific and technical potential of the region can be evidenced by the costs of technological innovations. The efficiency of production potential can be expressed by the indicator "Balanced financial result of the activities of organizations." The “Amount of debt on loans in roubles granted to legal entities” was selected as a factor indicative of the financial potential of the region. The expediency of choosing this indicator is justified

by the fact that entrepreneurs are increasingly turning to borrowed funds in their desire to expand production.

Figure 2. Indicators that determine the investment climate



Source: Compiled by the authors.

In order to develop an investment climate forecast based on the selected indicators, it is proposed to implement the simulation modelling toolkit. The research object was the Republic of Tatarstan. The initial data are shown in table 2.

Table 2. Retrospective information on the state of indicators characterizing the investment climate of the Republic of Tatarstan in 2002-2017.

Year	Average per capita monetary income of the population, roubles	Costs for technological innovations, mln. roubles	Balanced financial result of organizations' activities, million roubles	Amount of debt on loans in roubles provided by credit institutions to legal entities, million roubles
2002	3249	5219,1	27474	26 782
2003	4273	4548,4	42849	37 083
2004	5355	9298,4	86090	57 042
2005	7383	9887,4	98997	86 986,30
2006	9369	17568,4	91731	132 200
2007	11577	18893,1	139578	198 184,26
2008	14180	23731,3	98200	243 837
2009	15915	8262,5	122076	250 342
2010	18158	14351,1	140791	249 827
2011	20223	44166,4	194617	323 184
2012	24004	38101	245658	393 695
2013	26161	64436,5	219449	420 711
2014	29830	95720,7	201333	463 243
2015	32155	53353,8	308585	498 566
2016	32614	57571,1	358366	542 005
2017	31719	78404,6	314185	396 707

Source: Federal State Statistics Service. Access mode: https://www.gks.ru/.

To carry out the simulation procedure, it is necessary to form a block of initial data with predicted values for the next period. The calculation of the boundaries determining the range of changes in dependent factors was carried out based on the VAR method.(1). VAR modelling is based on a statistical assessment of the distribution law of the selected variable.(2). The basis for calculating the VAR was the data on the relative changes in the selected indicators over time (growth rates). Based on the calculated indicators of the arithmetic mean and standard deviation for each position, the average values for the optimistic, probable and pessimistic scenarios were determined. The algorithm for calculating the forecast values using the VAR method is considered by the example of the indicator "Average per capita monetary income of the population".

RESULTS AND DISCUSSION

Table 3 presents retrospective data covering the period from 2001 to 2017. The average growth rate indexes, the value of which was 17.81%, and the standard deviation of the growth rate, the value of which was at the level of 11.01%, have been calculated on this basis.

Table 3. Initial data for forecasting the boundaries of the range of changes in the average per capita money income of the population using the VAR method

Period	Value	Growth rate,%
2002	3249	x
2003	4273	31,52%
2004	5355	25,32%
2005	7383	37,87%
2006	9369	26,90%
2007	11577	23,57%
2008	14180	22,48%
2009	15915	12,24%
2010	18158	14,09%
2011	20223	11,37%
2012	24004	18,70%
2013	26161	8,99%
2014	29830	14,02%
2015	32155	7,79%
2016	32614	1,43%
2017	31719	-2,74%
Average growth rate,%		17,81%
RMS of growth rates,%		11,01%

Source: Calculated by the authors.

The next step in calculating the forecasted values is to determine the absolute changes (left and right quantiles). In statistics, a quantile is understood as the value of the normal distribution function for given random variables, for which the function does not exceed this value with a fixed probability., the probability value level of 95% was used to calculate the right quantile, and 5% for the left one.

According to the results of calculations, the value of the left quantile corresponds to -0.3% and the right one corresponds to 35.93%, which indicates that the increase in average per capita income will not exceed 35.93% with a probability of 95% (the maximum value is 43,114 roubles), and the decrease is by more than -0.3% (the minimum value is 31,622.9 roubles).

At the next stage, a range of changes in values was established. For this purpose, it is necessary to lay down a certain amount of error. The size of the error is directly related to the volatility of the indicator under consideration. The ranges of changes were calculated based on the calculated values of the standard deviation. So, the following ranges were obtained: (31,623; 35,453) for the pessimistic scenario, (35,453; 39,284) for the inertial scenario, and (39,284; 43,114) for the optimistic one. For other factors, the calculation was carried out in the same way. The results are shown in Table 4.

Table 4. Initial data for the simulation experiment

Index	Range of change		Extended spacing			
	min.	max.				
Gross regional product, million roubles	2 116 117	2 780 390	2 116 117	2 337 541	2 558 965	2 780 390
Average per capita monetary income of the population, roubles	31623	43114	31623	35453	39284	43114
Costs for technological innovations, mln. Roubles	22 814	185 802	22 814	77 144	131 474	185 802
Balanced financial result of the activities of organizations, million roubles	193 226	551 448	193 226	312 633	432 040	551 448
Amount of debt on loans in roubles provided by credit institutions to legal entities, million roubles	333 726	634 160	333 726	433 871	534 015	634 160

Source: Calculated by the authors.

The results obtained make it possible to proceed to the next stage of the study: carrying out simulation modelling. The method is based on a variety of experiments with randomly assigned values of indicators. 100 experiments were carried out; the results of the first 5 are presented in table 5.

Table 5. Simulation results

Experiment number	1	2	3	4	5
GRP, million roubles	2,333,213	2,705,433	2,449,588	2,439,278	2,640,516
Average per capita monetary income of the population, roubles	31,978	42,469	36,353	38,281	40,148
Costs for technological innovations, mln. roubles	62,286	168,892	99,356	97,607	158,968
Balanced financial result of the activities of organizations, million roubles	248,986	443,157	337,941	433,097	514,673
Amount of debt on loans in roubles provided by credit institutions to legal entities, million roubles	383, 788	623,074	490,621	457,671	578,597

Source: Calculated by the authors

SUMMARY

The algorithm proposed in this study makes it possible to systematically assess the directions that need to be adjusted for each group of regions, considering their unique features. For example, if a region is diagnosed with not high positions in scientific and technical potential relative to similar indicators on average in the country, then it becomes obvious that the implementation of target areas is required to ensure the correction of the formed vector of development in the territory of the analysed subject of the federation.

CONCLUSIONS

The estimates and results obtained can in many ways testify to the prospects and potential of economic development of individual regions in the context of the country's entry into the channel of the sixth technological order massively “covering” the global economy. Regions and economic agents, which are most actively integrated into new formats of impending business models, will provide themselves not only with the conditions for adaptation to the transforming economic conditions, but will also form a significant groundwork for competitive development for many decades.

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