

## ARTICLE

# DEVELOPMENT OF A MULTIFACTOR MODEL FORECASTING THE INVESTMENT ATTRACTION OF THE REGION

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### ABSTRACT

A high level of investment activity is a necessary factor in the sustainable socio-economic development of the regions, due to their investment attractiveness. In this regard, the development of research methods for the conditions that determine the nature of the investment activity of entities, the optimization of the management of investment processes in the regions is of particular importance, both for economic science and in the practice of managing regional systems at various levels. The lack of a unified approach to the study of investment attractiveness of the regions, the imperfection of methods for its determination and implementation practices hinder the effective management of the investment process at the regional and federal levels. 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 capable of predicting the flow of investment flows into the economy of the region. To solve this problem, a simulation modeling toolkit is proposed. The procedure for conducting simulation experiments involved the consideration of various factors contributing to the formation of the investment climate, taking into account possible scenarios. The components of the assessment of the investment attractiveness of the region were: consumer potential, scientific and technological potential, production potential, financial potential. An array of initial data necessary for the experiment was formed using VAR tools. Econometric processing of the obtained results was based on the interpretation of descriptive statistics. Based on the results of the study, a prognostic model is constructed that allows us to assess the dynamics of the investment climate in the medium term.

### INTRODUCTION

Investments play a crucial role in maintaining and enhancing the economic potential of the state. The growth of their volumes in the real sector has a positive effect on doing business in certain territories, which leads to an increase in gross national product as a whole, and increases the country's activity in the foreign market. Investment activity occupies a key place in carrying out political, economic and social transformations aimed at creating favorable conditions for sustainable socio-economic development of the state. Thus, from the position of successful implementation of the Government's course of modernization of the economy of the Russian Federation, the problem of increasing investment activity and improving the investment climate is currently one of the priorities.

The priority task of the state investment policy in Russia is to create optimal conditions for realizing the investment potential of the country's regions. Its main directions are related to measures to create favorable conditions for the activities of domestic and foreign investors, to increase profitability and minimize risks in the interests of stable socio-economic development, to increase the level and quality of life of the population, and to improve the economic situation in the country.

### MATERIALS AND METHODS

The topic of the investment climate has attracted the attention of many researchers in different countries, and a lot of research has been devoted to the analysis of the search for methods for improving the regional investment policy. Among them, in the context of our research task (to identify and explain which factors have the greatest influence on the formation of the investment climate, as well as develop a prognostic model), articles are particularly interesting, analyzing, firstly, indicators that determine the investment attractiveness of territories, and secondly, studies focused on modeling future revenues in the regional economy.

The richest in statistical data (and, as a consequence, relevant studies) is the American market. As a starting point, we can consider an article by P. Juhl of the late 1970s, which presented a list of indicators that determine the investment climate [1]. In subsequent years, researchers have made many attempts to model investment flows for various sets of indicators [2, 3]. In most cases, conclusions were drawn that for investors the following indicators have the greatest impact on the attractiveness of territories: geographical location, climate, natural resources, labor force qualifications, infrastructure, as well as financial indicators. M. Joarder in his work summarized the work on this topic [4]. The studies of Antwi S. and Nosheen M. continued [5, 6]. In their works, they showed that creating a favorable investment climate contributes to the economic growth of territories.

A number of works are devoted to the search and development of the methodological apparatus, with the aim of modeling investment flows in the economy. Some researchers use traditional methods of economic-mathematical analysis in their works [7, 8]. In their studies, the authors found that the use of this tool with a high degree of certainty allows us to predict the volume of investments.

#### KEY WORDS

Investment climate,  
investment  
attractiveness,  
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## RESULTS

The structure of the region's investment attractiveness is manifested in the complex characterization of the socio-economic object in many ways, showing the investor the degree of advisability of investing in it. The parameters by which attractiveness is assessed are determined by the purpose and object of investment.

The determining parameters are the parameters characterizing the effectiveness and riskiness of investment: socio-political, economic, industrial, natural-climatic and environmental.

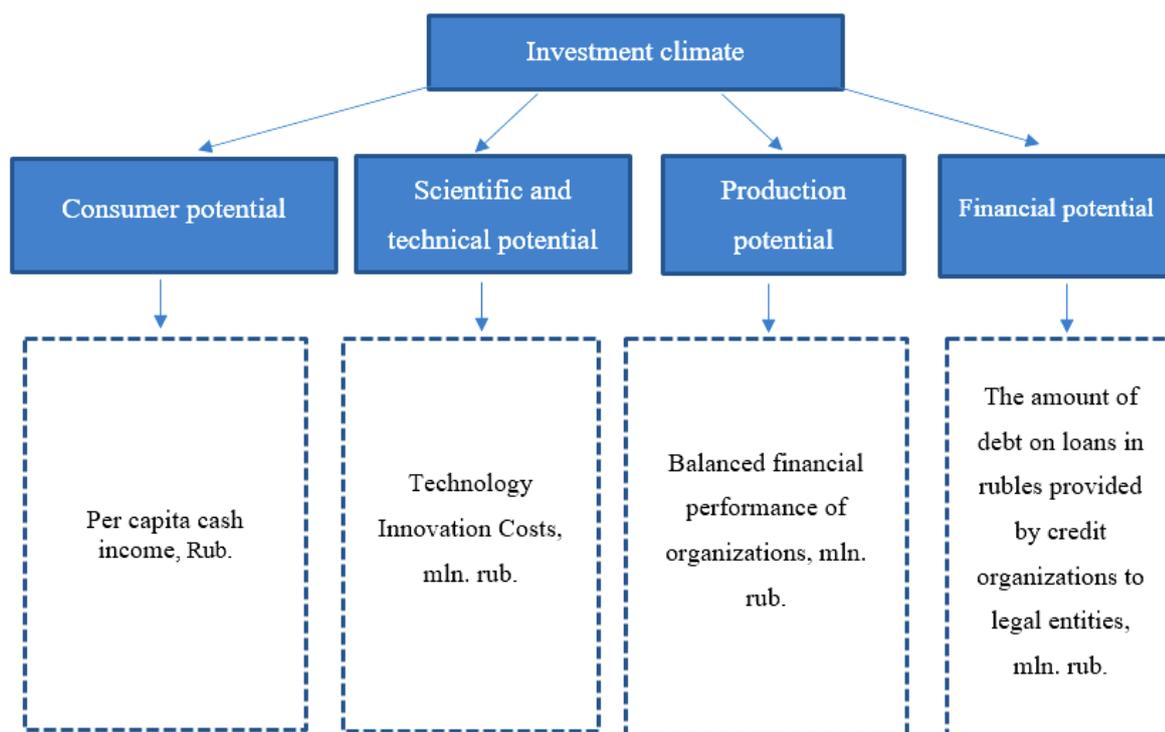
Using the identified set of factors affecting the state of the investment climate, this study attempts to use them in the framework of building an integrated index. In this connection, an important methodological element was the definition of this kind of common factors.

In this study, the following areas are identified as the directions 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 [Fig. 1].

A factor reflecting consumer potential was the average per capita cash income. The size of the population's 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 may be indicated by the costs of technological innovations. The efficiency of production potential can be expressed by the indicator "Balanced financial result of organizations".

As a factor testifying to the state of financial potential, "The amount of debt on loans in rubles granted to legal entities" was selected. The feasibility of choosing this indicator is justified by the fact that in their desire to expand production, entrepreneurs are increasingly turning to borrowed funds.



**Fig. 1:** Indicators determining the investment climate

In order to develop a forecast of the investment climate based on the selected indicators, it is proposed to implement simulation modeling tools. The Republic of Tatarstan acted as an object of study. The source data are shown in the [Table 1].

**Table 1:** Retrospective information on the state of indicators characterizing the investment climate of the Republic of Tatarstan in 2002-2017

Year	The average per capita cash income of the population, rub <sup>1</sup> .	Costs of technological innovation, million rub <sup>1</sup> .	Balanced financial performance of organizations, million rub <sup>1</sup> .	Amount of debt on loans in rubles provided by credit organizations to legal entities, million rub <sup>2</sup> .
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: 1. Federal State Statistics Service [9], 2. The Central Bank of the Russian Federation [10].

To carry out the simulation procedure, it is necessary to form a block of initial data necessary to determine the forecast values for the next period. The calculation of the boundaries of the range of changes in dependent factors was carried out based on the VAR technique.

VAR modeling is based on a statistical estimation of the distribution law of a selected variable. The basis for calculating the VAR was the data on the relative changes in the selected indicators in dynamics (growth rate). Based on the calculated indicators of the arithmetic mean value and standard deviation for each position, average values were determined for the optimistic, probable and pessimistic scenarios.

The algorithm for calculating forecast values by the VAR method is considered on the example of the indicator "Per capita cash income of the population".

[Table 2] presents retrospective data covering the period from 2001 to 2017, on the basis of which the average growth rate was calculated, the value of which was 17.81%, and the standard deviation of the growth rate, the value of which turned out to be at the level of 11.01 percent

**Table 2:** Initial data for predicting the boundaries of the range of changes in per capita monetary incomes 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%
Standard deviation of growth rate, %		11,01%

The next step in the calculation of forecast values is the determination of absolute changes (left and right quantiles). In statistics, a quantile is understood to mean the value of the normal distribution function for given random variables at which the function does not exceed a given value with a fixed probability. To calculate the right quantile, the probability level was used, the value of which was 95%, for the left 5%.

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

At the next stage, a range of changes in values was formed. To this end, it is necessary to lay a certain amount of error. The size of the error is directly related to the volatility of the indicator in question. The calculation of the ranges of changes was based on the calculated indicators of standard deviation. So, the following ranges were obtained: (31623; 35453) - for the pessimistic scenario, (35453; 39284) - for the inertial and (39284; 43114) for the optimistic. For other factors, the calculation was carried out in a similar way. The results are presented in [Table 3].

**Table 3:** Initial data for a simulation experiment

Indicator	Change range		Extended interval			
	min.	max.				
Gross regional product, million rubles	2 116 117	2 780 390	2 116 117	2 337 541	2 558 965	2 780 390
Average per capita cash income of the population, rub.	31623	43114	31623	35453	39284	43114
Costs of technological innovation, million rubles	22 814	185 802	22 814	77 144	131 474	185 802
Balanced financial performance of organizations, mln. Rub.	193 226	551 448	193 226	312 633	432 040	551 448
The amount of debt on loans in rubles provided by credit organizations to legal entities, million rubles	333 726	634 160	333 726	433 871	534 015	634 160

The results obtained allow us to move on to the next stage of the study - conducting simulation. The method is based on conducting many experiments with randomly specified values of indicators. 100 experiments were carried out, the results of the first 5 are presented in [Table 4].

**Table 4:** Simulation Results

Experiment Number	1	2	3	4	5
Gross regional product, million rubles	2 333 213	2 705 433	2 449 588	2 439 278	2 640 516
Average per capita cash income of the population, rub.	31978	42469	36353	38281	40148
Costs of technological innovation, million rubles	62 286	168 892	99 356	97 607	158 968
Balanced financial performance of organizations, mln. Rub.	248 986	443 157	337 941	433 097	514 673
The amount of debt on loans in rubles provided by credit organizations to legal entities, million rubles	383 788	623 074	490 621	457 671	578 597

Obtaining forecast values for each of the indicators allows us to move on to the main objective of the study - the determination of the integral index of the investment climate.

Undoubtedly, the selected list of indicators is not exhaustive, however, in our opinion, it forms to a significant extent the basic foundations that reveal the parameters and development trends of the investment attractiveness of the territories.

At the initial stage, for the purpose of comparability of indicators, the initial data were normalized relative to the gross regional product. The basis for the choice of the form of standardization is the direction of the relationship of the initial factors with a complex integral indicator.

Indicators of descriptive statistics for the calculated values are shown in the [Table 5].

**Table 5:** Descriptive Statistics Indicators

Indicators	Per capita cash income	Technology Innovation Costs	Balanced financial performance of organizations	The amount of debt on loans in rubles provided by credit organizations to legal entities, million rubles
The average value.	0,000015	0,0449	0,1551	0,2008
Standard deviation	0,000001	0,0168	0,0308	0,0217
Coefficients variations	4,20%	37,51%	19,87%	10,83%
Minimum	0,000014	0,0100	0,0941	0,1569
Maximum	0,000017	0,0698	0,2092	0,2455

As the data in the table show, the coefficient of variation of indicators selected as private terms for assessing the investment climate in the region ranges from 4.2% to 37.51%, which indicates a sufficient degree of uniformity of the forecast data array. Based on the results obtained, it can also be concluded that the average predictive values of the indicators are higher than the current ones, which indicates the growth prospects of the investment attractiveness of the Republic of Tatarstan.

The final index value was found as the sum of the values of the normalized indicators:

$$I_{ik} = I_{dd} + I_{techn} + I_{financial\ res.} + I_{cred} \quad (1)$$

Where,

$I_{ik}$  - index "Investment climate";

$I_{dd}$  - subindex "Per capita cash income of the population";

$I_{techn}$  - subindex "Costs of technological innovation";

$I_{financial\ res.}$  - subindex "Balanced financial result of organizations";

$I_{cred}$  - subindex "The amount of debt on loans in rubles provided by credit organizations to legal entities".

Graphically, the results of modeling the index in the first 50 experiments are presented in [Fig. 2].

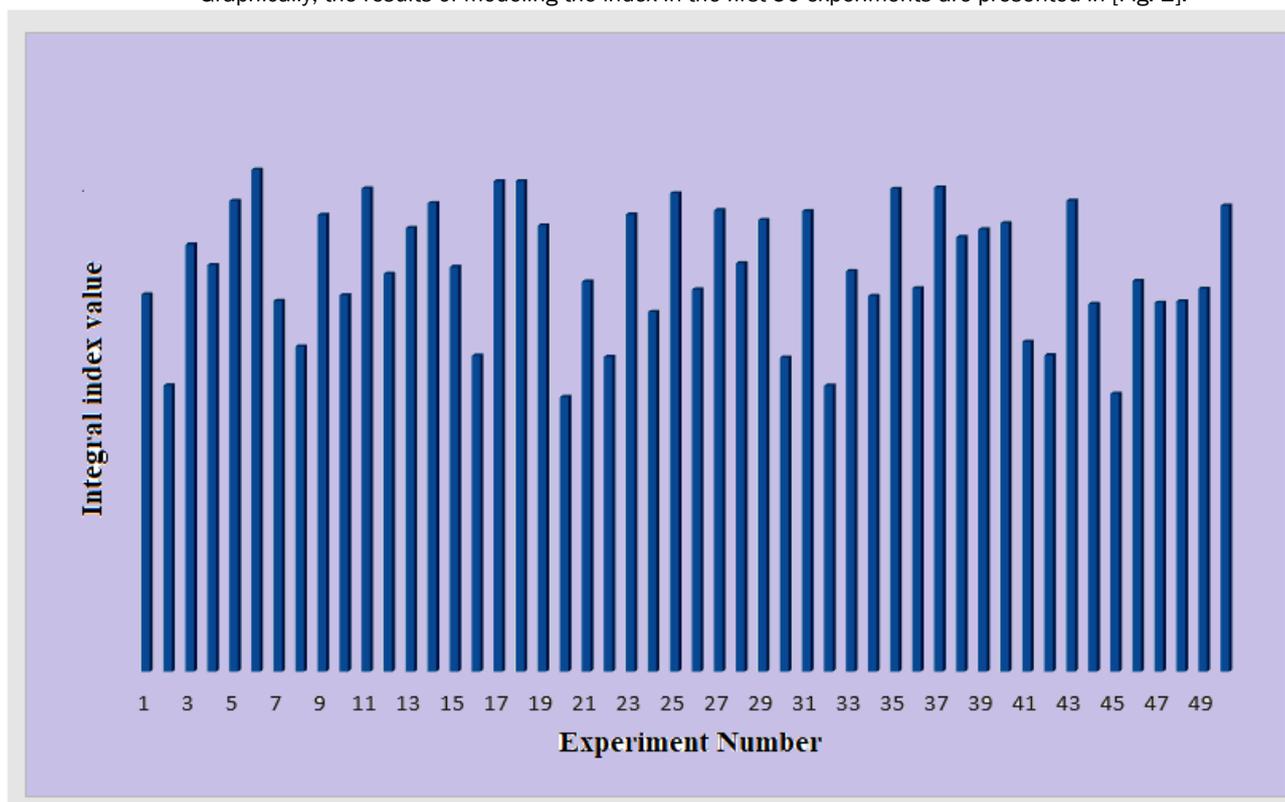


Fig. 2: Predicted values of the Investment Climate Index.

### SUMMARY

The results of the analysis revealed the features of the formation of the investment climate of regional economic systems in the framework of the concept of using a unified system of indicators. This opens up additional possibilities for interpreting development directions and developing conceptual proposals aimed at optimizing and improving the mechanisms for regulating regional economic processes.

### CONCLUSION

It should be noted that the findings are basically based on the approaches proposed in the study to the use of scenario forecasting techniques in the process of constructing regional models for the prospective assessment of the investment climate. The algorithm laid down in the research tools is aimed at the formation of stable principles of adaptive state policy in the face of significant uncertainty in modern development paths of macroeconomic processes.

### CONFLICT OF INTEREST

There is no conflict of interest.

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### FINANCIAL DISCLOSURE

None.

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