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Assessment of Investment Attractiveness of RF Entities Using Artificial Intelligence

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ABSTRACT

Difficult geopolitical situation in the world has made the issue of attracting private investment into the economy at the meso-management level relevant for Russia Currently, the solution of this problem is impossible without monitoring the investment attractiveness of the subjects of the Russian Federation. The purpose of the study is to develop an adequate methodology for assessing the investment attractiveness of Russian regions. Based on competitive benchmarking techniques, the investment attractiveness of territories (within the country) is assessed in dynamics over a number of years. The results of a retrospective assessment conducted using the index method are deepened by cluster analysis. Also, the authors' methodology allows us to assess not only the actual investment attractiveness of Russian regions, but also assumes the formation of a forecast. At the same time, the above tasks are solved with the help of artificial intelligence. The results of the retrospective assessment showed that in 2019–2022, Moscow and St. Petersburg were the pronounced leaders in the rating of investment attractiveness among the subjects of the Russian Federation. At the bottom of the rating (they did not rise above 71st place) on a regular basis were all the republics from the North Caucasus Federal District, as well as the Republic of Kalmykia and the Republic of Tyva, which are included, respectively, in the Southern Federal District and the Siberian Federal District. Based on the results of the cluster analysis, it can be seen that all Russian regions in 2019–2022 could be organized into three groups characterized by above-average, average and below-average levels of investment attractiveness. The quality of the formed cluster structure has improved over the entire analyzed period of time: the share of subjects of the Russian Federation with above-average investment attractiveness has almost doubled. The results of the (retro and prospective) assessment according to the authors' methodology allow us to conclude that there are significant reserves for the growth of investment attractiveness of all Russian regions without exception. Based on the decomposition of its results, the leadership of the constituent entities of the Russian Federation will be able to develop measures to improve the effectiveness of the regional investment policy.

Keywords: investment attractiveness; regions of Russia; balanced scorecard; index method; artificial intelligence; cluster analysis; forecasting

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INTRODUCTION

The complex geopolitical situation in the world due to the conflict between Russia and Ukraine (more precisely, the United States and the collective West) has made it difficult for our country to access investment resources. This affected the balance of payments of the Russian Federation. Thus, according to official statistical information,[1] foreign direct investment in the Russian economy amounted to USD 31.975, 9.479 and 40.450 million in 2019–2021, respectively. From the above data, it can be seen that periods of growth in the indicator's value alternated with years of sharp decline. Therefore, it is now becoming more important for the Russian leadership to ensure both the inflow of foreign direct investment into the economy from friendly countries (for example, BRICS and SCO partners) and the activation of private investors within the Russian Federation. In particular, the Minister of Finance of the country A. G. Siluanov has repeatedly spoken about the inability of the leadership of the Russian regions to attract investments.[2]

At the same time, a number of both Russian and foreign studies [1–7] allow us to draw an unambiguous conclusion that it is the managerial factor that plays a key role in increasing the investment attractiveness of the territory. Based on the above, the goal of this study is to propose an author's methodology that evaluates investment attractiveness at the meso-level of management using artificial intelligence. This goal involves solving several tasks: 1) a critical analysis of existing Russian methods for assessing the investment attractiveness of the region is carried out; 2) a proprietary index methodology is proposed for a retrospective assessment of the investment attractiveness of the subjects of the Russian Federation; 3) the results of the retrospective assessment are deepened by cluster analysis using the method of self-organizing maps by T. Kohonen, and 4) a forecast of the investment attractiveness of Russian regions is formed using a Bayesian ensemble of neural network models.

LITERATURE REVIEW

To date, quite a lot of scientific research has been accumulated on the assessment of investment attractiveness for various levels of management [8–16]. In [17], a not unsuccessful attempt was made to critically analyze a number of both Russian and foreign methods for assessing the investment attractiveness of enterprises and territories (country, region or municipality). Each of these methods was compared by the co-authors according to several criteria: 1) the main task to be solved; 2) the application of quantitative indicators and/or qualitative characteristics; 3) availability of the necessary background information for empirical research in the public domain and 4) ease of practical implementation of the approach. So, based on the second criterion mentioned above, all the variety of existing techniques can be combined into three groups: 1) statistical (index) approach; 2) point (expert) estimates; and 3) statistical-expert (mixed or hybrid) models. The first group is preferable from the point of view of ensuring the objectivity of the results of the final assessment, provided that the partial indicators (indicators) are equivalent. In the framework of this study, we will limit ourselves to considering several techniques.

The above-mentioned co-authors, based on the results of a critical analysis of existing approaches assessing the investment attractiveness of the territory, propose their own methodology for the constituent entities of the Russian Federation. The main difference between this methodology is the use of indicators that characterize the economic security of investment decisions made from the perspective of both the state

[1] Russian Statistical Yearbook. 2022: statistical collection. Moscow: Rosstat, 2022. URL: https://bigenc.ru/b/rossiiskii-statisticheskii-cd1a31?ysclid=m85hlhgk82687362424 (accessed on 10.10.2024).

[2] The habit of living on subsidies has not been eradicated. URL: http://www.pravda.ru/economics/rules/regions/27–03–2014/1202010-live-0 (accessed on 10.10.2024).

and entrepreneurs. At the same time, an evaluation scale with predefined interval boundaries based on the theory of fuzzy sets is used to distribute Russian regions by the level of investment attractiveness.

O. V. Loseva and M. A. Fedotova have developed a comprehensive methodology for assessing investment attractiveness for both enterprises and regions. In the second case, the co-authors understand the main components of such an assessment: 1) gross regional product; 2) intellectual capital; 3) resource potential and 4) socio-ecological indicators of the development of the subject of the Russian Federation [18]. At the same time, if the calculation of the generalizing indicator of the investment attractiveness of the region is carried out using the index method, then expert assessments can also be applied for individual of the above components. The latter circumstance increases the subjectivity of the final results obtained. However, it should be noted that the authors of [19] suggest certain ways to improve the traditional methodology of expert assessments: first, to verify the consistency of expert opinions (when assigning weights to components). Second, it is necessary to study the strength and closeness of the relationship not only between the resulting indicator and each of the factors, but also independent variables (based on the calculation and analysis of the values of paired correlation coefficients by K. Pearson).

The works [20, 21] present the author's methodology for assessing investment attractiveness at the meso-management level. A special feature of this methodology is the application of a system of balanced indicators for the regions of the country. At the same time, the works of R. Kaplan and D. Norton were taken as a basis. Quite a large amount of modern scientific literature is devoted to the development of the balanced scorecard concept [22–24]. However, until now, its use has been limited to the enterprise level [25–28]. For the first time, Russian scientists have adapted the concept for the subjects of the Russian Federation. However, in their research they limit themselves to a retrospective assessment and subsequent rating of the investment attractiveness of the constituent entities of the Russian Federation.

The deepening of a retrospective assessment of the investment attractiveness of a territory through cluster analysis using artificial intelligence (AI) remains a fairly rare phenomenon. At the same time, there are practically no studies devoted to the prospective assessment or forecasting of the investment attractiveness of a territory using AI. Thus, in [29] an attempt was made to fill the above gap in the scientific literature. This study is a logical continuation of the above scientific article. At the same time, its main methodological difference is the application of a system of balanced indicators for the regional management level.

EMPIRICAL RESEARCH: DATA, METHODS AND RESULTS

A retrospective assessment of the investment attractiveness of the constituent entities of the Russian Federation for 2019–2022 is carried out using the traditional index method. The information base of the empirical research is regional statistical data.[3] Taking into account the previously conducted review of scientific literature, a system of balanced indicators has been formed that make it possible to assess investment attractiveness at the meso-management level (*Table 1*).

The index (and sub-indexes) are calculated based on the following conditions: first, according to the simple arithmetic mean formula, i. e. with equal significance (without the use of weighting ratios) of all indicators. Second, for the purpose of data comparability, the normalization of indicator values is carried out in a minimax manner. Third, in order to ensure that information is

[3] Regions of Russia. Socio-economic indicators. 2023: statistical collection. Moscow: Rosstat, 2023. URL: https://bigenc.ru/b/regiony-rossii-sotsial-no-e-b75bfc?ysclid=m85ifu4dso252287392 (accessed on 10.10.2024).

Table 1

System of Indicators Assessing the Investment Attractiveness of Constituent Entities of the Russian Federation

Scorecard	Unit of measurement of the indicator	Assessment of the increase in the value of the indicator
I. Production and financial indicators		
1. The share of profitable enterprises	%	Positive
2. The ratio of revenue and expenditure parts of the consolidated budget of the subject of the Russian Federation	Ratio	Positive
3. The share of overdue accounts payable of organizations	%	Positive
4. The proportion of neutralized substances harmful to the atmosphere released by stationary sources 10. Profitability of goods, products, works and services sold by industrial organizations with manufacturing industries	%	Positive
5. The degree of depreciation of fixed assets	%	Positive
6. Profitability of assets of industrial organizations engaged in mining	%	Positive
7. Profitability of assets of industrial organizations with manufacturing industries	%	Positive
8. Profitability of assets of industrial organizations engaged in the production of electric energy, gas, steam and air conditioning	%	Positive
9. Profitability of goods, products, works and services sold by industrial organizations engaged in mining	%	Positive
10. Profitability of goods, products, works and services sold by industrial organizations with manufacturing industries	%	Positive
11. Profitability of goods, products, works and services sold by industrial organizations engaged in the production of electric energy, gas, steam and air conditioning	%	Positive
12. Profitability of the personnel of organizations	Thousand rubles/person	Positive
II. Development indicators		
13. The proportion of the employed population with higher education	%	Positive
14. The level (per 10,000 population) of university graduates	Person	Positive
15. The level (in the total volume of shipped goods, completed works and services) of the costs of innovation activities of organizations	%	Positive
16. Percentage of organizations using broadband Internet access	%	Positive
17. The coefficient of renewal of fixed assets	–	Positive
18. The coefficient of investment capacity of the sold products	–	Positive
19. The level (per 10,000 square kilometers of territory) of railway track length	Km of tracks	Positive
III. Natural resource indicators		
20. The level of participation in the workforce of the population	%	Positive
21. Electricity production per capita	KWh.	Positive

Table 1 (continued)

Scorecard	Unit of measurement of the indicator	Assessment of the increase in the value of the indicator
22. The level (per 100 people of the population) of active subscribers of mobile broadband Internet access	Units	Positive
23. The level (per 100 people of the population) of active subscribers with fixed broadband Internet access	Units	Positive
24. The ratio of autonomy for industrial organizations	%	Positive
IV. Political, socio-economic indicators		
25. Share of private enterprises and organizations	%	Positive
26. The share of small businesses in the turnover of organizations	%	Positive
27. Morbidity rate (per thousand people)	Units	Negative
28. The level (per thousand people of the population) of injuries of all types	Units	Negative
29. The level (per one thousand people of the population) of registered crimes	Units	Negative
30. The share of expenditures of the consolidated budget of the constituent entity of the Russian Federation on socio-cultural events	%	Positive
31. The proportion of the population with monetary incomes above the subsistence level (poverty line)	%	Positive
32. Unemployment rate	%	Negative

Source: Compiled by the authors.

subordinated to the law of normal distribution, if necessary, the normalized values of indicators are transformed by extracting the root of the (second-fourth) degree. Fourth, the cancellation of an abnormally high variation in indicator values is carried out as a result of the establishment of a standard (upper or marginal limit). And finally, fifth, the cost indicators and their derivatives are determined in comparable prices, taking into account both the inflationary processes in the country and the different purchasing power of the ruble in the regions. The results of the rating of the constituent entities of the Russian Federation by investment attractiveness in dynamics for 2019–2022 are presented in *Table 2*.

As presented in *Table 2,* while Moscow was the leader of the rating in the first three years of the analyzed period, St. Petersburg rose from 2nd to 1st place in 2022. It should be noted that only in these two subjects of the Russian Federation, in certain years of the analyzed period, the value of the investment attractiveness index exceeded 0.7. There was also a stable group of outsider regions in the rating — all the republics included in the North Caucasus Federal District, and two entities from the Southern Federal District and the Siberian Federal District (respectively, the Republic of Kalmykia and the Republic of Tyva) — ranked 71st to 82nd annually.

The results of the retrospective assessment are deepened by cluster analysis. Within the framework of this study, such an analysis is carried out using AI (using the method of self-organizing maps by T. Kohonen). Ensuring the adequacy of the procedure implemented in the demo version of the Deductor Studio Lite software product is confirmed by the data in *Table 3*.

Table 2

Rating of Investment Attractiveness of Constituent Entities of the Russian Federation

Territory (Russian region)	The value of the investment attractiveness index of the Russian region				Place of a constituent entity of the Russian Federation in the ranking of investment attractiveness			
	2019	2020	2021	2022	2019	2020	2021	2022
Belgorod region	0.653	0.659	0.690	0.653	9	4	4	11
Bryansk region	0.550	0.502	0.536	0.531	48	58	61	62
Vladimir region	0.544	0.545	0.580	0.606	53	47	45	27
Voronezh region	0.662	0.673	0.650	0.653	6	2	15	12
Ivanovo region	0.514	0.501	0.533	0.527	63	59	62	65
Kaluga region	0.567	0.529	0.562	0.533	39	54	52	60
Kostroma region	0.570	0.552	0.589	0.584	37	42	40	43
Kursk region	0.663	0.652	0.687	0.670	5	5	5	6
Lipetsk region	0.621	0.605	0.667	0.639	15	17	11	17
Moscow region	0.649	0.624	0.640	0.646	10	9	19	14
Oryol region	0.514	0.564	0.584	0.606	62	35	42	26
Ryazan region	0.567	0.575	0.580	0.584	40	29	44	42
Smolensk region	0.539	0.553	0.590	0.578	54	41	39	45
Tambov region	0.511	0.562	0.546	0.558	64	36	56	52
Tver region	0.501	0.491	0.558	0.565	68	63	54	48
Tula region	0.624	0.594	0.640	0.665	14	20	18	7
Yaroslavl region	0.560	0.546	0.571	0.595	44	46	49	37
The city of Moscow	0.719	0.696	0.725	0.698	1	1	1	2
The Republic of Karelia	0.559	0.544	0.576	0.579	45	48	46	44
Komi Republic	0.561	0.496	0.563	0.527	43	60	50	64
Arkhangelsk region	0.491	0.453	0.515	0.529	70	73	68	63
Vologda region	0.573	0.569	0.597	0.621	36	32	36	22
Kaliningrad region	0.608	0.582	0.617	0.602	22	26	29	30
Leningrad region	0.618	0.587	0.620	0.637	19	23	27	18
Murmansk region	0.618	0.652	0.686	0.653	20	6	6	10
Novgorod region	0.507	0.494	0.574	0.596	65	62	48	35
Pskov region	0.493	0.467	0.533	0.514	69	70	64	68
St. Petersburg	0.709	0.661	0.703	0.703	2	3	2	1
The Republic of Adygea	0.455	0.487	0.487	0.475	76	65	73	74
The Republic of Kalmykia	0.397	0.446	0.471	0.439	80	74	77	78
The Republic of Crimea	0.480	0.465	0.508	0.519	72	71	70	67

Table 2 (continued)

Territory (Russian region)	The value of the investment attractiveness index of the Russian region				Place of a constituent entity of the Russian Federation in the ranking of investment attractiveness			
	2019	2020	2021	2022	2019	2020	2021	2022
Krasnodar region	0.595	0.574	0.606	0.591	25	31	34	40
Astrakhan region	0.597	0.560	0.576	0.558	23	37	47	53
Volgograd region	0.580	0.559	0.545	0.543	33	38	57	58
Rostov region	0.582	0.578	0.621	0.614	30	28	26	24
The City of Sevastopol	0.506	0.478	0.495	0.560	66	68	71	49
The Republic of Dagestan	0.398	0.382	0.413	0.422	79	79	79	79
The Republic of Ingushetia	0.394	0.361	0.368	0.359	82	82	82	82
The Kabardino-Balkarian Republic	0.397	0.379	0.404	0.383	81	80	80	81
The Karachay-Cherkess Republic	0.477	0.416	0.478	0.449	73	78	76	77
The Republic of North Ossetia-Alania	0.487	0.461	0.466	0.480	71	72	78	73
The Chechen Republic	0.402	0.379	0.384	0.396	78	81	81	80
Stavropol region	0.577	0.587	0.622	0.598	34	24	25	33
The Republic of Bashkortostan	0.568	0.535	0.593	0.586	38	50	38	41
The Republic of Mari El	0.464	0.474	0.541	0.552	75	69	58	56
The Republic of Mordovia	0.549	0.531	0.550	0.558	49	53	55	51
The Republic of Tatarstan	0.662	0.605	0.667	0.681	7	16	10	3
The Udmurt Republic	0.552	0.531	0.561	0.560	47	52	53	50
The Chuvash Republic	0.536	0.483	0.514	0.526	55	66	69	66
Perm region	0.619	0.575	0.654	0.641	18	30	14	16
Kirov region	0.530	0.547	0.581	0.550	59	45	43	57
Nizhny Novgorod region	0.620	0.609	0.655	0.637	17	15	13	19
Orenburg region	0.563	0.555	0.615	0.599	42	40	30	31
Penza region	0.577	0.568	0.608	0.599	35	33	33	32
Samara region	0.620	0.601	0.659	0.612	16	18	12	25
Saratov region	0.596	0.550	0.599	0.565	24	43	35	47
Ulyanovsk region	0.530	0.495	0.538	0.556	58	61	60	54
Kurgan region	0.523	0.502	0.490	0.498	60	57	72	72
Sverdlovsk region	0.639	0.618	0.668	0.602	11	11	9	29
Tyumen region	0.629	0.595	0.643	0.653	13	19	17	9
Chelyabinsk region	0.612	0.614	0.644	0.642	21	13	16	15
Altai Republic	0.535	0.533	0.530	0.556	57	51	66	55

Table 2 (continued)

Territory (Russian region)	The value of the investment attractiveness index of the Russian region				Place of a constituent entity of the Russian Federation in the ranking of investment attractiveness			
	2019	2020	2021	2022	2019	2020	2021	2022
The Republic of Tyva	0.436	0.444	0.483	0.462	77	75	75	76
The Republic of Khakassia	0.504	0.440	0.630	0.648	67	77	23	13
Altai region	0.556	0.581	0.614	0.593	46	27	31	38
Krasnoyarsk region	0.691	0.645	0.698	0.660	3	7	3	8
Irkutsk region	0.669	0.642	0.672	0.674	4	8	8	4
Kemerovo region	0.536	0.483	0.635	0.636	56	67	21	20
Novosibirsk region	0.634	0.615	0.677	0.672	12	12	7	5
Omsk region	0.588	0.589	0.613	0.617	28	22	32	23
Tomsk region	0.584	0.526	0.595	0.603	29	55	37	28
The Republic of Buryatia	0.548	0.565	0.585	0.597	51	34	41	34
The Republic of Sakha (Yakutia)	0.548	0.543	0.563	0.574	52	49	51	46
The Trans-Baikal region	0.548	0.510	0.533	0.539	50	56	65	59
Kamchatka region	0.582	0.612	0.631	0.532	31	14	22	61
Primorye region	0.521	0.491	0.525	0.514	61	64	67	69
Khabarovsk region	0.592	0.593	0.623	0.595	27	21	24	36
Amur region	0.580	0.556	0.541	0.507	32	39	59	70
Magadan region	0.655	0.622	0.637	0.592	8	10	20	39
Sakhalin region	0.594	0.586	0.620	0.630	26	25	28	21
The Jewish Autonomous region	0.470	0.443	0.485	0.504	74	76	74	71
Chukotka Autonomous region	0.565	0.549	0.533	0.475	41	44	63	75

Source: Compiled by the authors.

As presented in *Table 3*, all the constituent entities of the Russian Federation can be correctly attributed to a specific cluster (with the individual approximation error not exceeding 5%).

The distribution of Russian regions by investment attractiveness and their cluster structure are shown in *Fig. 1* and *2*.

As presented in *Fig. 1*, all the constituent entities of the Russian Federation, based on the achieved index values, can be correctly grouped into three clusters characterized by above-average, average and below-average levels of investment attractiveness. In the analyzed period (with the exception of the reporting year), the Republic of Bashkortostan was consistently included in the second cluster, which is consistent with the results of the ranking of the country's territories. The specified region occupied almost the median position in the ranking, with the exception of 2020 (there was a failure, and the republic, with an index value of 0.535, fell back to 50th place).

Table 3

Assessing the Adequacy of Cluster Analysis Results

Year	Maximum error	Average error	Recognized, %
2019	$2.32 * 10^{-3}$	$3.63 * 10^{-4}$	100
2020	$2.65 * 10^{-3}$	$3.75 * 10^{-4}$	100
2021	$3.82 * 10^{-3}$	$3.61 * 10^{-4}$	100
2022	$7.19 * 10^{-3}$	$3.54 * 10^{-4}$	100

Source: Compiled by the authors.

As presented in *Fig. 2* over the entire analyzed period of time, there was an increase in the quality of the formed cluster structure (in terms of investment attractiveness) of the constituent entities of the Russian Federation.

Thus, there was a significant (almost twofold) increase in the share of Russian regions with an above-average level of investment attractiveness. For the above reason, the total share of the constituent entities of the Russian Federation included in the first and second clusters reached 87.8% by 2022. Despite this, there are currently no Russian regions characterized by high investment attractiveness. Further, using AI, also in the demo version of the Deductor Studio Lite software product, a promising assessment of investment attractiveness is carried out using the example of two regions-the leaders of the rating and the Republic of Bashkortostan. For this purpose, a Bayesian ensemble of neural network models of topology multilayer perseptron of different configurations is formed (*Table 4*).

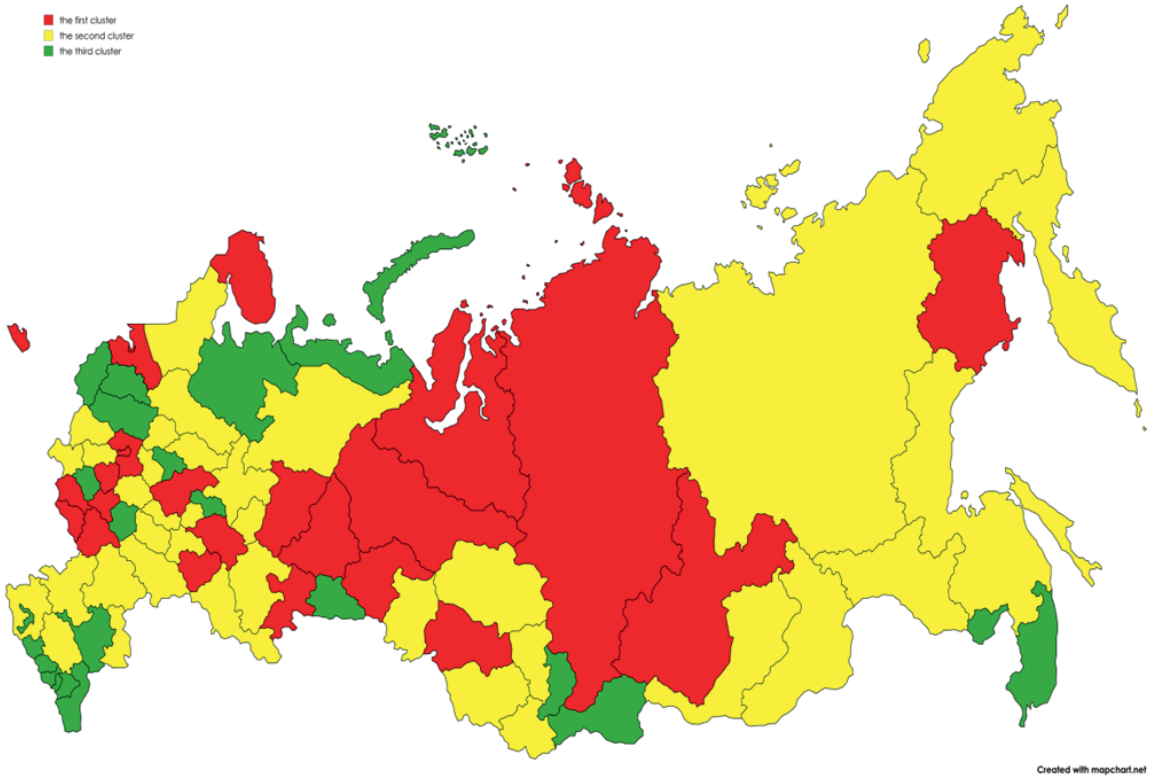
The output indicator of the models is the index value, and the input variables are the first and fourth sub-indexes. Due to the relatively small number (148) of observations, they completely constitute a training sample (without a teacher). The indicated number of observations included indicators for 2019–2022 for 36 regions from 3 federal districts (Central, Northwestern and Southern), as well as the Republic of Bashkortostan, which is part of the Volga Federal District.

Adequate neural network models were included in the Bayesian ensemble (*Table 5*).

As presented in *Table 5*, the average approximation error for the Bayesian ensemble was 2.6% and varied in the context of neural network models in the range from 2.2 to 2.8%. Most (three out of five) of the neural network models made it possible to correctly (with an individual approximation error within 8%) almost completely (over 98%) recognize all observations. About 83–93% of the "good" ones (the individual approximation error did not exceed 5%). The points were guaranteed by each of the neural network models included in the Bayesian ensemble. Hence, it allows you to obtain a promising assessment of investment attractiveness with a high degree of accuracy.

Fig. 3 shows the results of forecasting (for 2024–2025) for the leading regions and the Republic of Bashkortostan.

This forecast is based on the planned values (targets) of the first and fourth sub-index in the amount of 0.65 / 0.67 and 0.76 / 0.77; 0.7 / 0.71 and 0.73 / 0.75; 0.58 / 0.6 and 0.66 / 0.67, respectively, for the cities of Moscow, St. Petersburg and the Republic of Bashkortostan for 2024 / 2025. According to the results of the prospective assessment, the city of Moscow with an index value of 0.719 / 0.724 is expected to occupy a leading position with some margin from St. Petersburg (0.716 / 0.72). At the same time, the performance indicator for the Republic of Bashkortostan is also projected to grow by 3.6% in 2024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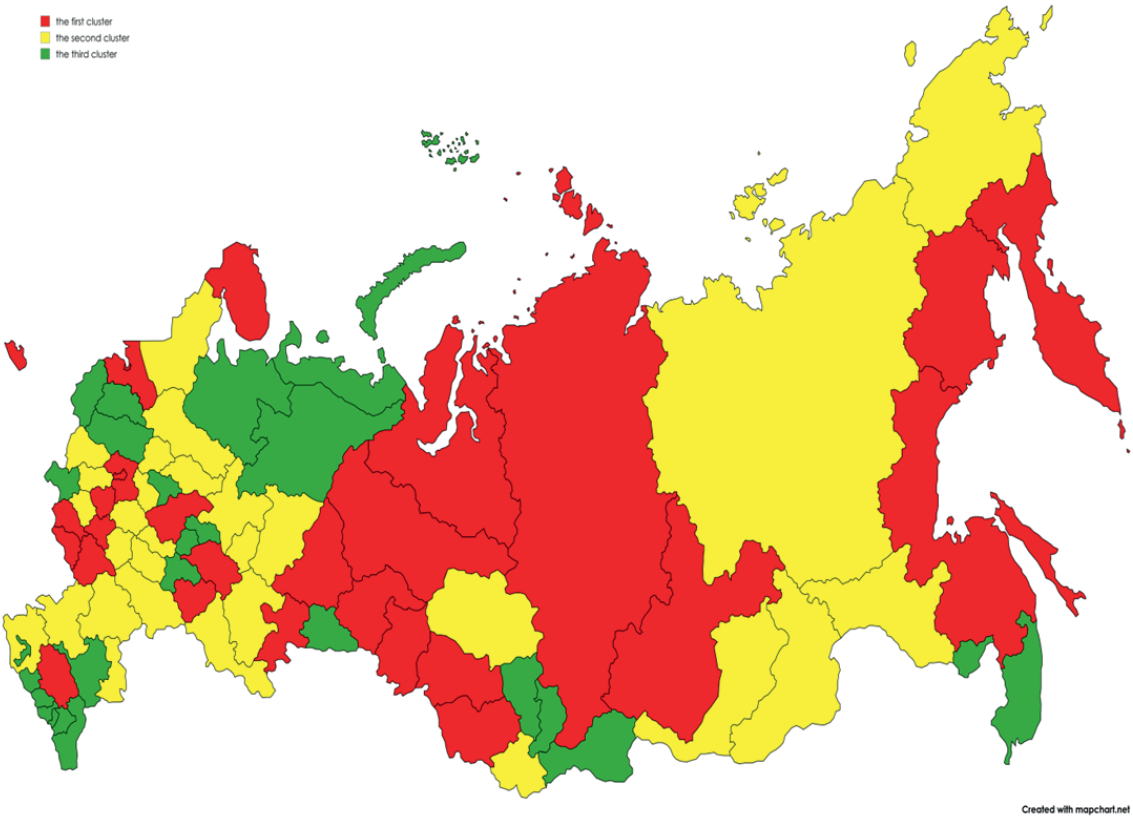
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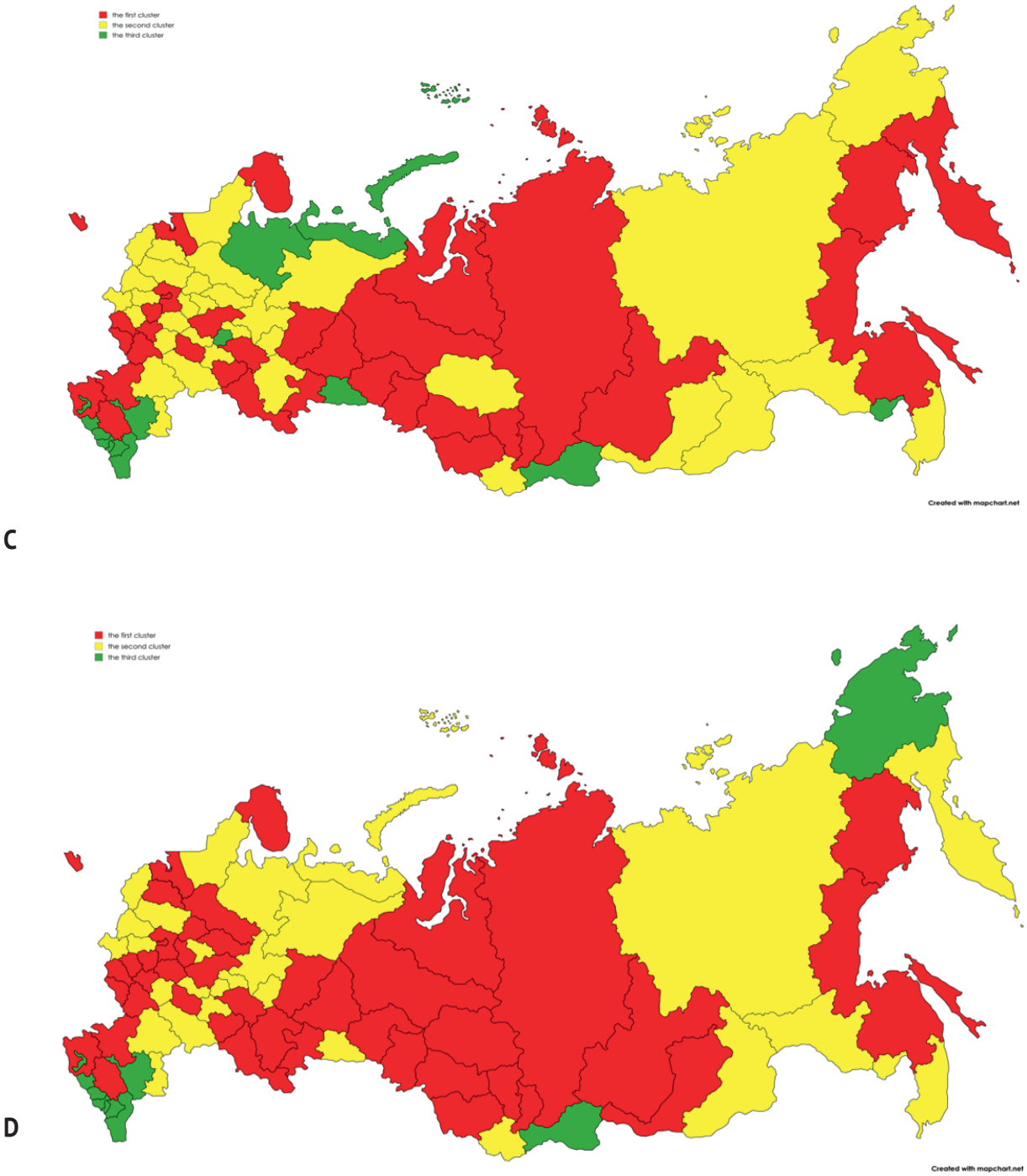

Fig. 1. **Distribution of Russian Regions by Investment Attractiveness in 2019–2022**

Note: The Republic of Crimea and the city of Sevastopol belonged to the 3rd and 2nd cluster in 2019–2021 and 2022

Source: Authors' calculations.

and by 2.8% in 2025. However, in 2024–2025, a significant gap in the index value between the cities of Moscow / St. Petersburg and the Republic of Bashkortostan is expected to remain.

Therefore, based on the results of the empirical study, the conclusion can be drawn that the leading regions currently have significant reserves for increasing investment attractiveness.

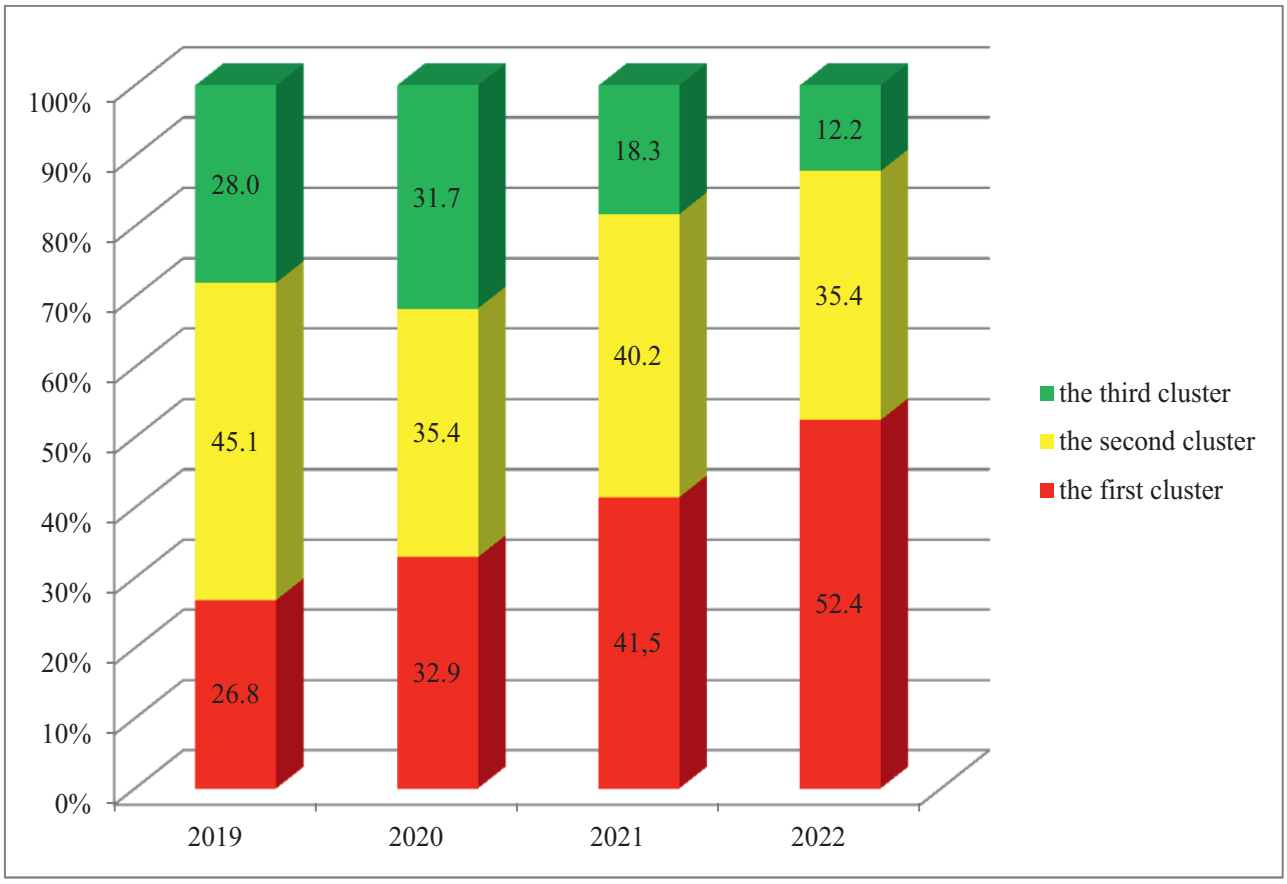

Fig. 2. **Cluster Structure of the Constituent Entities of the Russian Federation (by Level of Investment Attractiveness)**

Source: Authors' calculations.

Table 4

Configuration of Neural Network Models Included in the Bayesian Ensemble

Neuromodel number	Hidden layers	Number of neurons in 1st / 2nd hidden layer
1st	1	4 / –
2nd	1	6 / –
3rd	1	8 / –
4th	2	4 / 6
5th	2	6 / 8

Source: Compiled by the authors.

CONCLUSIONS

To date, a fairly large amount of scientific literature has been accumulated on assessing the investment attractiveness of a territory (country, region, or municipality). At the same time, only index (statistical) methods ensure the objectivity of the final evaluation results. The concept of the balanced scorecard by D. Norton and R. Kaplan is quite popular abroad. However, it is used exclusively for micro-level management. In the work of Russian scientists [20, 21], the concept was

Table 5

Assessing the Adequacy of Neuromodeling Results

Neural network model	Average approximation error, %	The number of correctly recognized observations		Percentage of correctly recognized observations, %		The largest approximation error, %
		ε < 5%	ε < 8%	ε < 5%	ε < 8%	
1st	2.8	131	88.5	142	95.9	11
2nd	2.6	127	85.8	147	99.3	9.4
3rd	2.8	124	83.8	146	98.6	9.5
4th	2.7	128	86.5	143	96.6	12.1
5th	2.2	138	93.2	148	100	7.4
The ensemble of neuromodels	2.6	130	87.6	145	98.1	9.9

Source: Compiled by the authors.

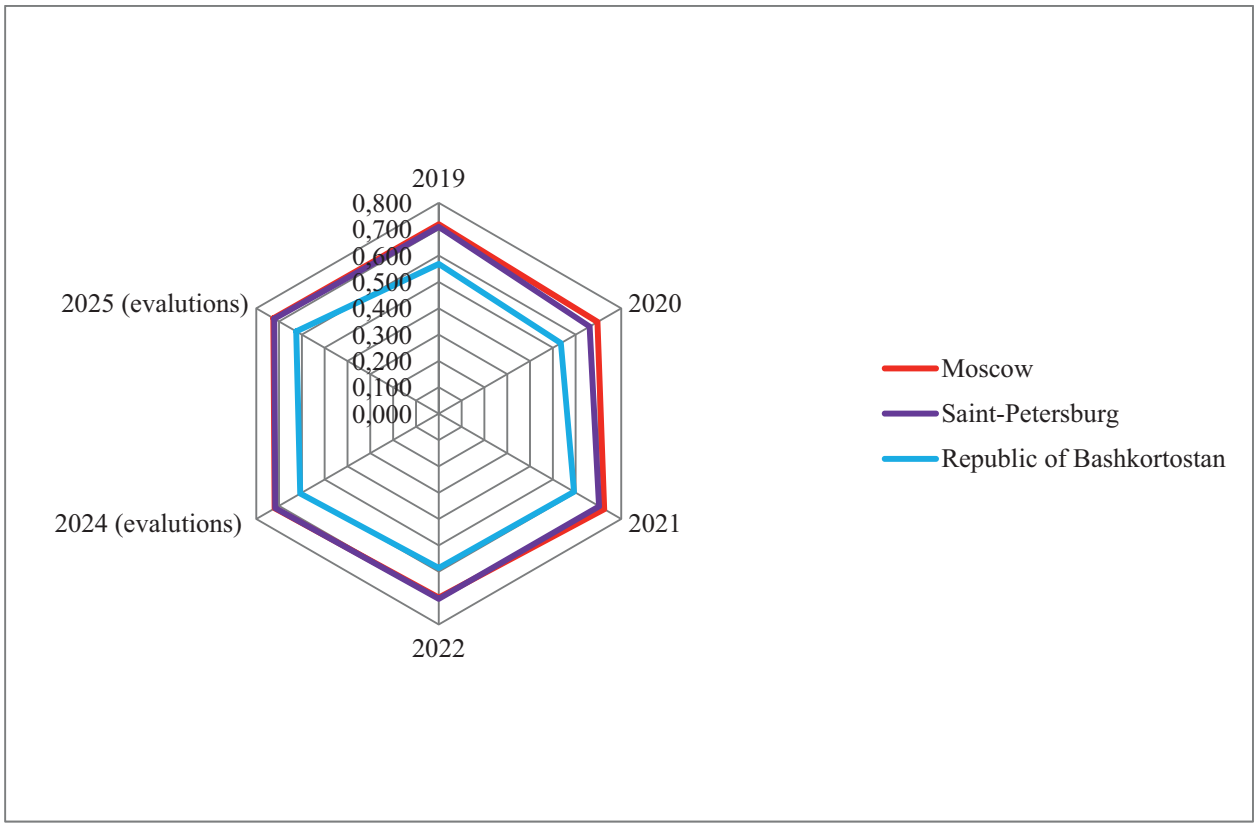

Fig. 3. **Prospective Assessment of the Investment Attractiveness of the Leading Regions and the Republic of Bashkortostan**

Source: Authors' calculations.

adapted to the specifics of the territory for the first time.

When constructing the index of investment attractiveness of Russian regions, a balanced data system is also used in this work. At the same time, the number of indicators is optimized (in the direction of decreasing) in comparison with the above work. In terms of the methodology for calculating the index, the current study takes into account the peculiarities of ranking the subjects of the Russian Federation by the level of innovative development proposed by the Higher School of Economics.[4]

In comparison with well-known methods, the author's approach is not limited to a retrospective assessment of the investment attractiveness of Russian regions. Thus, with the help of AI, clusterization and forecasting of the investment attractiveness of the subjects of the Russian Federation are consistently carried out. The results of the empirical study can serve as a scientific basis for improving the regional investment policy of any Russian region. The decomposition of the final assessment will make it possible to identify areas (on a differentiated basis) for increasing the investment attractiveness of almost every constituent entity of the Russian Federation.

[4] Rating of innovative development of constituent entities of the Russian Federation. Issue 7. Moscow: National Research University Higher School of Economics, 2021. URL: https://www.hse.ru/primarydata/rir2021?ysclid=m85jf5n9ej741632923 (accessed on 10.10.2024).

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