Advances in Economics, Business and Management Research, volume 47

International Scientific Conference "Far East Con" (ISCFEC 2018)

Investment Prospects of the Region

O.S. Buslaeva, V.S. Serova, E.V. Bunova
South Ural State University
Chelyabinsk, Russia
buslaevaos@susu.ru

D. B. Solovev [*,**]
[*]Far Eastern Federal University,
[**]Vladivostok Branch of Russian Customs Academy
Vladivostok, Russia
solovev.db@dvfu.ru

***Abstract*— This article is devoted to mathematical modeling of the investment attractiveness of the region. To build the model of the investment attractiveness, it was proposed to use the method of the eigenstates. A distinctive feature of this method is, above all, the possibility of using a large number of factors affecting on scoring factor. The model of investment attractiveness of Chelyabinsk region was built by using of the eigenstate method. After the analysis, the reserves to increase the investment were identified. The proposed method is universal and can be used not only for regions but also for countries.**

***Keywords*— investment appeal, region, analysis, principal component, eigenstate method**

I. INTRODUCTION

Social and economic development of regions is strategically important aspect in the long term for steady increase in welfare of the Russian citizens, national security. The publication of the report "Our future" in 1987 which author is "the commission Bruntdland" [the commission of the UN for the environment and development] [1] became the beginning for wide dissemination of the concept of sustainable regional growth. Importance of maintenance of social and economic development of regions is also emphasized in the Concept of long-term social and economic development of the Russian Federation for the period till 2020 [N 1662-p is approved by the order of the Government of the Russian Federation in November 17, 2008] [2]. Other countries pay much attention to formation of strategy of regional growth, for example the Czech Republic in which the document "Strategy of Regional Growth of the Czech Republic" [3] is also accepted. Social and economic development of the region is of great importance in aspect of attraction of new corporate investments [4].

Assessment of social and economic development of the region is based on consideration economic, social and economic aspects [3]. Social and economic development of the region is the central function of authorities of the region, which becomes especially urgent during the economic crisis. Social and economic development of the region is impossible without additional financial infusions in its economy. However the investor, putting the finance in development of this or that branch of the region, it has to be sure that the capital invested by it will work, and will bring in a certain income to the owner. In this regard, before making the positive decision on investments, the investor has to be able to estimate positive and negative [risks] consequences of the made decisions.

The conventional world agencies, which are carrying out assessment of level of investment appeal, are Moody's, S&P and Fitch. These companies provide service of assessment of risk of investments, assignments of rating to the companies and the countries, by means of assignment of a title of "the good payer" at assessment of investment risks. In work [5] it is told about that, there are two levels of investment assessment by the agencies. Public solvency which value exerts impact on granting the credit by borrowers is estimated at the first highest investment level. Ranging of the companies on investment risks is carried out at the second corporate investment level.

These agencies estimate probability of insolvency of the financial liability use of internal techniques. The basis of internal techniques is made by 11 indexes linked to the cyclical economic and financial structure, covering aspects of liquidity, profitability, debt, and income.

Now there is a large number of techniques of the analysis of investment appeal [5-9]. For example, in work [6] at the heart of calculation of an index of investment appeal the following indicators lie: liquidity indexes, profitability indexes, debt indexes, and income indexes, based on quotients of immediate liquidity, current ratio, quick ratio, Ebitda, solvency, asset turnover, total debt, net equity debt, asset income, and net equity income.

Unfortunately, the uniform technique of the analysis and assessment of investment appeal of the region or the enterprise does not exist now, as in Russia, and abroad. All existing techniques can conditionally be divided into three groups [7]: economic-mathematical methods (method of the sum of places, method of ball estimates, Pattern method, etc.), methods of the factorial analysis and expert methods. On other classification presented in work [9] there are three approaches to techniques of assessment of investment appeal of regions. The first approach reveals fundamental factors which existence, for example, dynamics of gross domestic product or the output of industrial output unambiguously defines investment appeal of the region. The second approach is based on the accounting of several equal factors, such as development of market infrastructure, social, financial, etc. For the third approach, investment appeal of the region is defined by two characteristics: investment potential and investment risk.

Drawback of all methods is, as a rule, groundlessness of inclusion in model of this or that factor, impossibility of definition of a contribution of this or that indicator to total

assessment and existence of expert estimates. Besides, abroad now develops and it is widely applied to the analysis of activity of complicated economic systems - it is the analysis of the environment of functioning (Data Envelopment Analysis) [6] based on methodology of linear programming. The essence of this method is that a difficult object with a set of entrances is investigated (as a rule, expenses are considered as an entrance) and exits (for example, release of the production) and its activity in the environment of functioning is analyzed. The main drawback of this method is first of all that in case of a multidimensional task the defined limits of efficiency become indistinct.

Method of expert evaluations, which has subjectivity of expert, estimates and low efficiency of ratings because of delays in collection of information is most often used now at assessment of all factors used in the analysis of investment appeal of regions by authors of methods.

II. THE PROCEDURE OF CONSTRUCTING THE MODEL OF EVALUATION AND INVESTMENT ATTRACTIVENESS ANALYSIS OF THE REGION

Eigenstate Method is proposed for the analysis of investment prospects of the region. [10] The method is successfully used in problems of image analysis [11], in taking management decision [12] and so forth. The essence of the method is to analyze the quality modifications of the region activity indicators during the year.

According to this method, all input data (factors) are grouped into clusters within which factors are interrelated but the clusters (eigenstates) are independent. Thus, the state of any system at any given time is described by a linear combination of eigenstates. In each eigenstate original factors may vary in proportion to their weights.

In general, the construction of the model of region investment attractiveness can be divided into five steps.

The first step is to choose the indicators describing the level of the region economic development and characterizing the investment quote that are used for estimating return on investment in regional development.

At the second stage, the requirements to the region investment attractiveness, which impose certain restrictions on the model key factors relationship, are specified. For example, analyzing the investment prospects of the region we can say that the increase in investment in the region entails an increase in the gross regional product. The constructed model is an idealized representation of the object behavior.

The third stage includes a description of the object activity as a set of independent processes, i.e. eigenstates that characterize a definite trend of the region development. Eigenstates can be calculated using the second moments matrix of a set of indicators. Eigenstates are independent (the first property of eigenstates [9]), i.e. the change of one trend (eigenstate) does not affect the change of other trends (eigenstates). Thus, the removal of one of eigenstates would not change the other eigenstates. Within each trend (eigenstate) values vary in proportion to the weights of eigenstates (the second property of eigenstates [9]). The weighted coefficients of eigenstates are determined by their eigenvectors of the second moments matrix of a set of indicators.

At the fourth stage, we analyze if eigenstates meet the requirements put forward to the investment attractiveness of the region and construct the model of the investment-attractive region.

If the requirements of the investment attractiveness of the region are represented as indicators with standard values, we calculate indicators values for each eigenstates. The indicator of region investment attractiveness is the ratio of exponents x_{i} and x_{j}. As part of h eigenstate, these exponents values are determined by the formulas $x_{ki}^{h} = \mathrm{V}_{hi} z_{kh}$ and $x_{kj}^{h} = \mathrm{V}_{hj} z_{kh}$ where V_{hi} - coefficients of eigenstates of i-th index, Z_{kh} – the principal component of the h eigenstate for kth observation. Then the coefficient of the region investment attractiveness, described by h eigenstate, is calculated according to the formula $\mathrm{K}_h = \mathrm{V}_{hi} z_{kh} / \mathrm{V}_{hj} z_{kh} = \mathrm{V}_{hi} / \mathrm{V}_{hj}$. Thus, the index of investment prospects of the region h eigenstate is the ratio of the weighted coefficients and variables of x_{i} and x_{j}. Comparing the value of the indicator with its standard value, a decision about the choice of eigenstate for the model of the region with investment appeal is made.

Selected eigenstates are used to generate the model of investment-attractive region (a reference model). The deduced model is an idealization of the real functioning of the region and serves as a reference for the examined area in terms of investment attractiveness. Indicators describing the region operation within the framework of the investment attractiveness model are determined by the formula:

$$x_{ki}^{et} = \bar{x}_i + \sum_{h=1}^{P} \mathrm{V}_{hi} \mathrm{z}_{kh} \qquad (1)$$

where p – the number of selected eigenstates used to build the model.

At the last stage, the analysis of the object investment attractiveness is carried out by comparing the reference value with the initial data. Comparing actual performance with reference ones shows how the actual socio-economic state of the object corresponds to the reference state. The reference values are calculated on the basis of the standard model of investment attractiveness. Large deviations (eg, deviations of more than 5-10%) of the reference values can be interpreted as an attendant instability of the region development, and as a consequence a decrease in its investment attractiveness. These deviations from the reference socio-economic indicators of the region functioning are interpreted as signs of the system destabilization and are measured using the penalty function.

Comprehensive indicator of the socio-economic object investment attractiveness can be calculated by the following formula:

$$R_i = 1 - \overline{f_k}, \quad (2)$$

where $\overline{f_k}$ - the rms value of the penalty function indicators, which are defined as:

$$\overline{f_k} = \sqrt{\frac{1}{r}\sum_{i=1}^{r} f_{ki}^2}, \quad (3)$$

where r - the number of indicators that are included in the calculation of comprehensive indicators, f_{ki} - the value of the penalty function j^{th} indicator for the k^{th} observation. The value of the penalty function can be calculated by the formula:

$$f_{ki} = \begin{cases} 0, & if \ \left| x_{ki} - x_{ki}^{et} \ \middle/ x_{ki} \right| < \varepsilon_d \\ \left| x_{ki} - x_{ki}^{et} \ \middle/ x_{ki} \right|, & if \ \left| x_{ki} - x_{ki}^{et} \ \middle/ x_{ki} \right| \geq \varepsilon_d \end{cases}, \quad (4)$$

where x_{ki} - the actual value of the indicator, x_{ki}^{et} - the reference value of the indicator, ε_d - the acceptable deviation.

As we see from the formula (4) the fines are assigned to the parameters which values differ from the reference value by more than the allowable value.

Thus, the use of the logical-mathematical model of external and internal environment indicators influence on the region investment appeal allows to analyze the main indicators of the region functioning as a socio-economic object rapidly and detect abnormalities that may lead to the loss of investment attractiveness in good time.

III. EXAMINATION OF THE INVESTMENT PROSPECTS OF THE RUSSIAN REGION

We study the socio-economic performance of Chelyabinsk region by constructing a model of an investment attractive region using the method of eigenstates.

First of all, we need to select those indicators which (in our opinion) significantly affect the investment attractiveness of the region. All indicators can be grouped into clutters according to certain criteria. To build the model following indicators of the region development were taken (30 indicators):

• economic indicators (taken per capita), such as an internal regional product, investment in equity, retail volume, foreign investment in the region, etc.;

• indicators describing the social area in the region: the density of roads, average income (per capita), the commissioning of residential buildings, morbidity, etc.;

• environmental performance of the region: the level of radiation pollution, pollutant emissions;

• indicators of the crime situation in the region: the unemployment rate, the number of registered crimes.

Indicators of the political situation in the region are not included in the model, because the political situation in the regions is the same within the country. Political factors are the most important (in this case) to assess the investment risks for the country, not for the region.

Constructing the model by eigenstates method, the duration of the exploration period is very important. Selection is based on statistical indicators that characterize the potential of the country. These figures are included in the data book provided by the Federal State Statistics Service. The exploration period is 12 years. Thus, a matrix composed of selected indicators with 30x12 dimensions was obtained.

Table 1 presents the socio-economic indicators of the region functioning.

TABLE I. SOCIO-ECONOMIC INDICATORS OF THE REGION FUNCTIONING

Year	FCE	GRP	PI	LMC	EP	RT	BPL	UR
2002	9255	47775,7	3108	47,4	903	18490	29,7	11,6
2003	10225	61444,7	3998	46,1	910	23037	24,5	3,5
2004	14094	81894,8	4820	39,8	945	29343	21,8	33,7
2005	20641	99159,8	4969	36,9	880	41639	14,9	95
2006	25436	127442,5	6554	32,7	996	56657	12,3	93
2007	37482	16797,5	8655	24,2	970	72055	11,6	44
2008	51910	190565,5	10700	27,9	958	97783	10,6	79
2009	41755	159901	14120	37,3	798	99592	10,8	149
2010	43442	187673,7	15215	31,2	749	107344	10,2	140
2011	50777	223105,2	16821	32,7	694	121151	10,8	124
2012	55364	242150	19816	28,6	678	99139	10,1	20
2013	60499	252100	21888	31,8	667	110583	11,2	113

The following notations of the main indicators are introduced in the table and further as the text goes: FCE - fixed capital expenditures, GRP - gross regional product per capita, PI - population income per capita, RT - retail turnover per capita, LMC (loss-making companies) – a share of loss-makers, EP - emissions of pollutants into the atmospheric air, BPL - the share of population income below subsistence line, UR - unemployment rate1.

Fixed capital expenditures indicator is chosen as main factor. The target factors (factors that attract the most interest for the analysis) are GRP, retail turnover per capita, BPL and LMC (the share of unprofitable enterprises).

Graphic presentation of the analyzed parameters is shown in fig 1.

Then we formulate the requirements the constructed model is to meet. Investment growth, in our view, should lead to an increase in GRP, population income per capita growth and, consequently, to an increase in retail turnover. However, it

should be noted that in the volatile economic environment period in the country population income per capita growth may not lead to an increase in retail turnover. This is due to the fact that the population in this period usually sit tight and reserve a part of savings in the form of deposits. The growth of investment in the region contributes to the creation of new jobs and, consequently, a decrease in unemployment rate, a decrease in the crime rate, the development of new technologies, etc. Thus, formulating the criteria we will focus on the following: Investment growth leads to an increase in gross regional product, to an increase in population income per capita, to unprofitable enterprises share reduction, to decrease of the share of population income below subsistence line. There are no restrictions imposed on the other indicators.

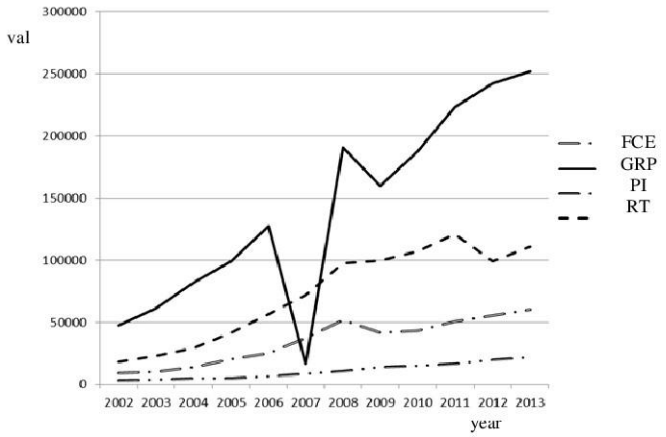

Fig.1 The dynamics of the base (FCE) and the target (GRP, PI, RT) indicators.

Eigenstates are calculated during the third phase. The calculation of the eigenstates weight are shown in Table 2.

TABLE II. THE WEIGHT NUMBER OF EIGENSTATES

indicator	eigenstates number					
	1	**2**	**3**	**4**	**5**	**6**
FCE	0,129	-0,097	0,206	0,161	0,285	0,018
GRP	0,576	0,806	-0,111	0,068	-0,036	0,013
PI	0,048	-0,037	0,019	-0,031	-0,010	-0,072
LMC	-0,003	0,007	-0,014	-0,019	-0,017	-0,010
EP	-0,078	0,039	0,083	0,230	0,223	0,078
RT	0,253	-0,066	0,744	0,060	0,208	-0,044
BPL	-0,004	0,001	-0,014	-0,008	-0,009	-0,029
UR	0,019	0,052	0,141	-0,121	0,028	0,295

Analyzing eigenstates, it stands to reason that for the reference model construction it is needed to consider the first seven eigenstates as from the eighth dispersion becomes zero. Consequently, all following eigenstates can be discarded because they do not make a special contribution to the investment model in the region.

It should be noted that not all eigenstates meet the criteria stated above. Therefore, in the fourth stage of the eigenstates analysis we select those, which meet the criteria.

According to the first of eigenstates growth in fixed capital investment leads to GRP increase, population income growth as well as retail turnover. Along with the investments growth, a reduction in the share of unprofitable enterprises, the reduction of polluting emissions and the number of people with incomes below the subsistence minimum is in evidence. The second eigenstate suggests that the decrease in investment leads to growth of gross regional product, to an increase in the unprofitable enterprises share, polluting emissions, the number of people with incomes below the subsistence level and the number of unemployed. This is accompanied by a decrease of the population income per capita and retail turnover. Similarly it is possible to analyze the rest of eigenstates. The analysis of eigenstates has shown that the first and the seventh eigenstates are corresponded to the criterion introduced above.

Knowing the eigenvalues, the initial values of these factors can always be found. Thus, the investment attractiveness of the Chelyabinsk region in any of the periods can be determined by a weighted combination of eigenstates. In this case, not the original factors but a set of eigenstate is used for description of the region investment attractiveness. Each principal component includes more than one factor, typically, their combination. On the basis of eigenstates it is possible to build a reference model of the investment attractiveness of the region. The reference model shows how the basic socio-economic indicators in the ideal system should be changed in order to achieve the investment attractiveness of the region. Picture 2-5 shows a comparison of base values and indicators calculated by the method of eigenvalues (the reference model).

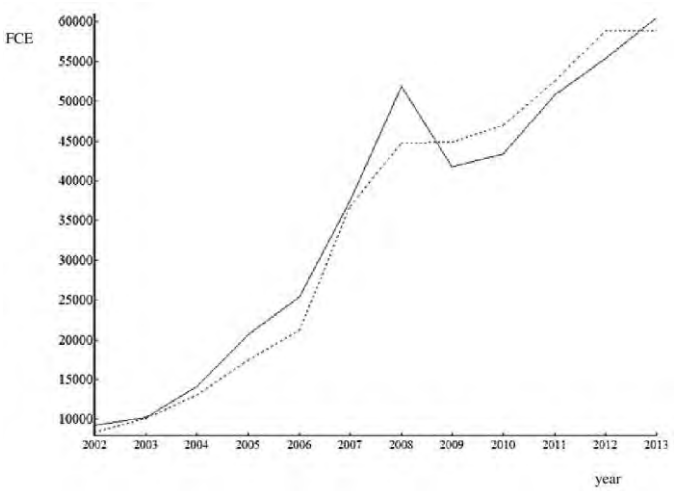

Fig. 2. Fixed capital expenditures (solid line is a model, dashed line is the original values)

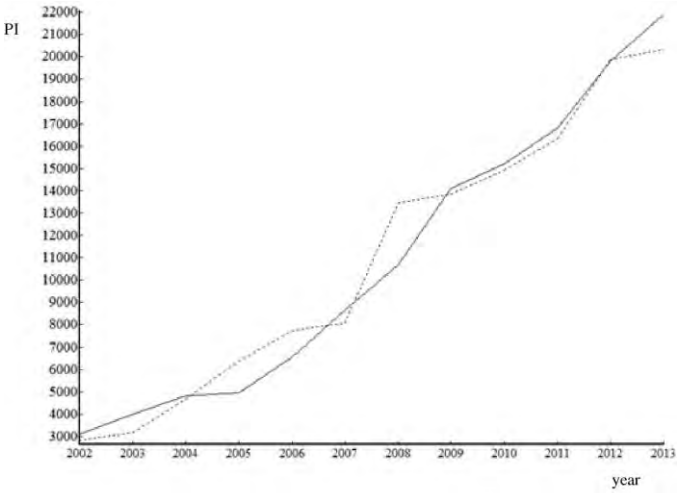

Fig. 3. Population income per capita (solid line is a model, dashed line is the original values)

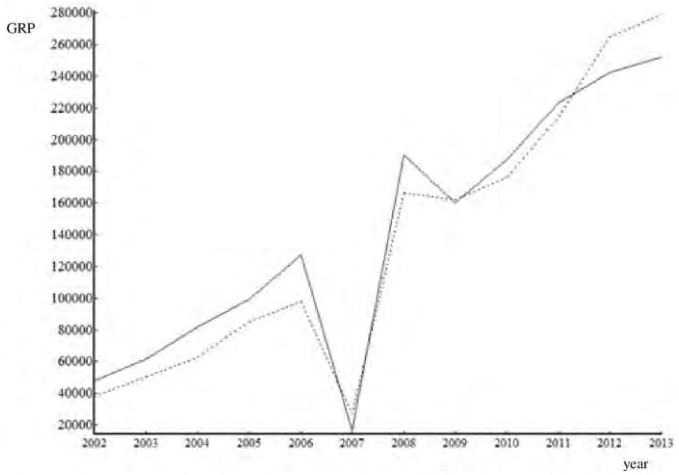

Fig. 4. The gross regional product per capita (solid line is a model, dashed line is the original values)

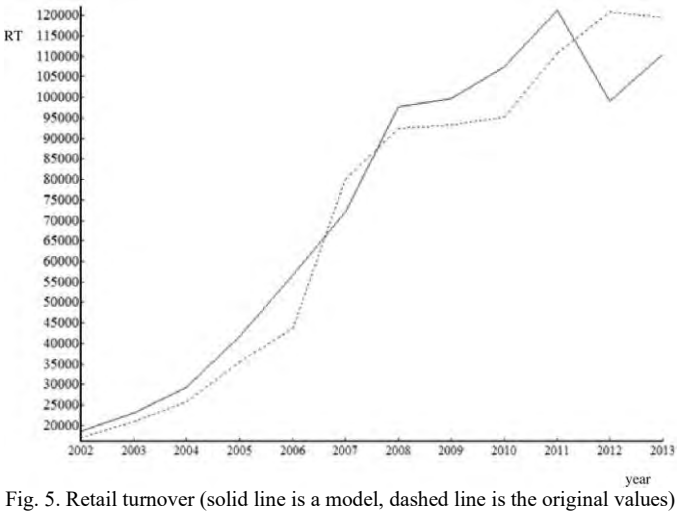

Fig. 5. Retail turnover (solid line is a model, dashed line is the original values)

As it is seen from these graphs, the reference model describes the original data quite well. Since 2009 there has been a decline in fixed capital expenditures in comparison with the reference model (Pic. 2). This is primarily due to the tense political situation in the world and the beginning of the global economic crisis. Certain deviations from the reference model are also observed in the case of the analysis of the retail turnover (Pic. 5). From 2008 to 2011, there was quite a sharp increase in the retail turnover in comparison with the reference values. This is due to the credit policy of the Russian banks (relaxation in the requirements for credited parties, borrowers age-limit increase, and so on). Since 2012 conversely there has been a sharp decline in retail turnover. This is primarily due to the economic crisis and the political situation in the country: loan default, interest rate increase, the introduction of economic sanctions, and consequently decline in consumer purchasing power.

To evaluate the investment attractiveness of the region a complex indicator that is calculated using a formula (1), is built. When calculating the complex indicator we assume that any deviation by more than 10% from the reference value is a sign of instability. The penalty function values are calculated according to the formula (3), if $\varepsilon_d \geq 10\%$.

Penalty function values are shown in Table 3, and the complex indicator change is shown on picture 6. As can be seen from the table penalty functions reach their maximum values at the beginning of the period (2002-2006) and at the end of the period starting in 2011.

As we can see in picture 6 there is a sharp fluctuation of the investment attractiveness of the region until 2006 and since 2012.

It is possible to ease the requirements for the complex indicator, i.e. to reduce the number of factors considered in the indicator calculating. So if we impose the penalty function under negative deviation above the allowable values only on the following factors: fixed capital expenditures, the GRP and population income per capita, we can see that a complex indicator ranges within 0.9 ... 1.0 (Table 4). . It proves that investment policy in the region is satisfactory.

TABLE III. PENALTY FUNCTION VALUES

year	Indicator						
	GRP	PI	LMC	EP	RT	BPL	UR
2002	0,027	–	0,6617	0,6241	–	0,7172	0,1591
2003	0,0246	–	0,6745	0,6945	–	0,7049	0,3824
2004	0,078	–	0,5362	0,5308	–	0,6195	–
2005	–	0,0107	0,3901	0,382	–	0,4483	0,3586
2006	0,0489	0	0,2473	0,3579	–	0,3091	0,2602
2007	0,1799	–	–	–	–	0,0921	0,1763
2008	–	–	–	0,0855	–	–	–
2009	–	–	–	–	–	–	0,1954
2010	–	–	–	–	–	–	0,154
2011	–	–	–	–	–	–	0,1057
2012	–	–	0,1817	0,1955	0,0292	0,2085	0,6435
2013	–	–	0,1284	0,2186	0	0,169	–

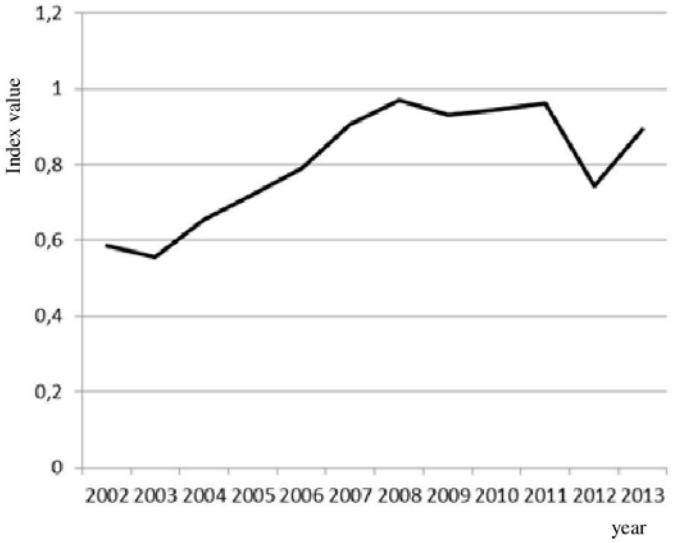

Fig 6. Complex indicator change

TABLE IV. COMPLEX INDICATOR RANGES

year	indicator	year	indicator
2002	1,00	2008	1,00
2003	1,00	2009	1,00
2004	0,98	2010	1,00
2005	0,99	2011	1,00
2006	0,98	2012	1,00
2007	0,90		

Thus, the developed theoretical apparatus can be used to make management decisions related to the selection of an object for investment (from the point of view of the investor). From the point of view of the CEO this unit can be used to assess the investment potential of socio-economic object and to make management decisions to improve its investment attractiveness.

IV. CONCLUSIONS

This article examines the actual theme dedicated to the evaluation, analysis and maintenance of the investment attractiveness of the region. The urgency of the problem is determined by the need to develop the region control mechanism according to the criterion for investment attractiveness, as currently existing methods do not allow to reveal the hidden mutual relations between socio-economic indicators of the region functioning. To solve the problem of definition, analysis and maintenance of the investment attractiveness of the region it is encouraged to use the methodology of constructing a model of the region having the investment attractiveness using the method of eigenstates. This methodology allows, while reducing the number of indices of the region socio-economic performance to identify their structure and relationships and to build a generic or complex indicator of the investment prospects of the region. Comprehensive indicator of investment attractiveness of the region is determined by comparing the actual parameters and the reference activity of the region, using the method of penalty functions. The proposed methodology involves the formation of a set of indicators describing the economic, social, ecological processes and indicators of the crime rate; formulation of the region investment attractiveness requirements; calculating eigenvector describes the eigenstates of the region functioning which is characterized by a definite tendency of its development and verification of eigenstates compliance with the investment attractiveness requirements. The paper presents the formula for calculating the complex indicator of investment attractiveness of the region. In this article, the efficiency of the developed methodology is demonstrated on the example of the Chelyabinsk region investment attractiveness analysis and can be used for other regions.

References

[1] The report of the world Commission on environment and development. – UN 1987. – 412 p.

[2] The concept of long-term socio-economic development of the Russian Federation for the period until 2020 (approved. the decree of the RF Government dated 17 November 2008 N 1662-R)//collected legislation of the Russian Federation. – 2008. – № 47. - St. 5489.

[3] Myskova R. Assessment of conditions for enterprising in selected regions using the Regional Economic Development Risk indicator // Wseas Transactions on Business and Economics. Volume 10, 2013. pp. 268-277.

[4] Sergio Cavagnoli Guth, Maria Emilia Camargo, António Jorge Fernandes, Maria Elizabeth Pereira Teixeira Rocha. Investment Grade, defined By an Economic and Financial Indicator. WSEAS Transactions on Business and Economics, Volume 12, 2015, Art. №23, pp. 249-260

[5] HILL, C. Regulating the Rating Agencies. American Law & Economics Association Annual Meetings. Chicago-Kent College of Law. Chicago. 2004.

[6] Cooper, W. W. Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References, and DEA-Solver Software / W. W. Cooper, L. M. Seiford, K. Tone.– Boston : Kluwer Academic Publishers, 2000. – 318 p.

[7] Zvyagentseva O The economic problems of regions and branch complexes // Problems of modern economy. - 2010. - №1 (33). p. 1-7.

[8] Savushkina O.V. Methodical aspects of the investment appeal analysis of the region spheres of economy // Social and economic phenomena and processes. – 2013. - №1 (047). - p. 160-163.

[9] Kuzmin V., Chepik D. To a question of an assessment of investment appeal of the region // Economics of Agriculture of Russia. – 2014. - № 2. - p. 40-43.

[10] Mokeyev V.V. The method of principal components and the method of eigenstates for the analysis and prediction. Chelyabinsk: South Ural State University, 2014. 144 p.

[11] Mokeyev V.V. Improving the efficiency of principal components computation in image analysis tasks. // Digital signal processing. -2011. - №4. - p. 29-36,

[12] Mokeev V, Pluzhnikov V. Principal component analysis as means to improve the administrative decisions efficiency in enterprise structures // Vestnik of SUSU series "Economics and Management". - 2011. - №41. - 149-154.