The European Proceedings of
Social & Behavioural Sciences
EpSBS

Future Academy ISSN: 2357-1330

https://dx.doi.org/10.15405/epsbs.2019.03.02.288

SCTCMG 2018
International Scientific Conference «Social and Cultural Transformations in the Context of Modern Globalism»

MODELLING OF INVESTMENT ATTRACTIVENESS AND ECONOMIC STABILITY OF REGION

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Abstract

A systematic study of the modeling investment attractiveness and economic stability of region has been carried out. A priori, current and a posteriori investment objective are picked out. A general description of investment attractiveness of the Kabardino-Balkarian Republic, one of the subjects of the North Caucasus Federal District, is given. One of the conditions for attracting a potential investor is a reliable assessment of the investment territory attractiveness. For these purposes, the authors, using the information-entropy approach, developed a model for assessing the investment attractiveness and region economic stability, which was based on the passive investment strategy and the generalized Cobb-Douglas production function. In the process of developing the model, basic investment parameters were considered of the Kabardino-Balkarian Republic. Twenty variables (the volume of attracted domestic and foreign investments, the number of the working-age population) are used).

The proposed integral model can be used both to assess the investment attractiveness of a region, as well as for taxonomy and ranking organizations, regions by level of investment activity. The quantitative and qualitative levels of the classification of state investment attractiveness of an economic object are determined. The application fields of the research results are programs and strategies for regional development, sectoral planning, forecasting the dynamics of gross regional product based on investment growth.

Keywords: Investment, modelling, Cobb-Douglas function, region. ,

https://dx.doi.org/10.15405/epsbs.2019.03.02.288
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eISSN: 2357-1330

1. Introduction

Nowadays economic growth, an increase in investment activity and a buildup of innovative resources are observed in certain supporting regions only, whereas in the so-called depressed regions only the subsequent, residual spread of investment and innovation activity continues. The polarization principle of the Russian economy development as the strategy basis of innovative modernization of the regional economy is unacceptable. At the same time, both old and new institutions, investment activity tools do not ensure the realization of the innovation scenario of various types of Russian regions, especially problematic ones. The study of the scientific research results shows that the state largely declares the country's movement along the formation path of an innovation economy. In fact, it is forced to carry out this movement in conditions when the regions differ not only in the volume of the gross product or in separate generalized macroeconomic indicators, but also in different steps of the economic development "quality", which is now objectively observed.

The investment management system at the regional level duplicates the investment project management system of a single business unit. It aims to achieve several goals: a priori, current and posteriori. A priori goals are related to investment planning. They mean a justification of investment strategies and policies, an assessment of acceptable risk levels and a profitability of investment instruments, a determination of optimal sources of financing investment activities. Current goals are directly related to the implementation of investments. They mean a determination of the optimal structure of investment portfolio, an organization of regular monitoring of external and internal factors of the investment environment, an adoption of corrective investment decisions. A posteriori goals are associated with the results of investment activities. In other words, they mean development of accounting indicators system, control and effectiveness evaluation of investment activities. An achievement of a priori, current and a posteriori goals is possible using various techniques and approaches that can be classified according to the investment object as active and passive.

Active methods are used to manage investment assets, which are highly profitable, high-risk and at the same time short-term financial instruments. These methods are based on the systematic monitoring of the financial market, the search for irrelevant priced securities, forecasting (modeling), expert evaluation of changes in their value and profitability in the future. Passive methods are used to manage investment assets that have the following characteristics: a low level of profitability, riskiness, and usually a long circulation period. An investor using passive methods is guided when making management decisions on the market index profitability indicators, and the structure of the formed investment portfolio is permanent and changes only to adaptively approach the chosen yield trajectory (Rossokhin, 2012).

An attraction, a placement, a diversification of investments and a management of the region's investment portfolio are a multidimensional process that requires relevant methods, narrowing the "underinvestment - reinvestment" strip. It is important to have appropriate resources to predict and adapt to changes in investment conditions. Here, passive investing has an advantage in order to effectively manage risks, diversify, minimize deviations from the target yield curve and maximize the evolutionary potential of the investment portfolio.

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2. Problem Statement

A. Al'bekov, V. An'shin, YU. Bogatin, A. Bystryakova, G. Kleyner, E. Velichko, V. Zolotogorov, N. Igoshina, E. Bukhval'd, A. Amosova, V. Denisova, B. Koltynyuk, V. Kosov, L. Kruvshits, I. Lipsits, A. Margolin, YA. Melkumova, S. Prilipko, R. Samuseva, A. Smolyak, V. Savchuk studied the conceptual and methodological issues of managing regions in the conditions of differentiation and asymmetry of the development of their economies, investment design and evaluation of the effectiveness of regional investments.

Various aspects of assessing the investment attractiveness of economic entities are reflected in the studies of L. Beklaryan, V. Vlasovoy, M. Egorovoy, A. Ivanova, E. Krylova, A. Nedosekina, I. Sakharova, V. Sobolevoy, E. Khrustaleva. Among other researchers it should be noted the works of G. Aleksander, G. Arnol'd, V. Berens, R. Breyli, G.V. Beyli, E. Granta, D. Dina, Ch. Kanta, Kh. Levi, S. Mayyersa, R. Payka, S. Rossa, P. Khavraneka (Endovitskiy, 2017).

It can be stated that in recent years works on the development of management tools have appeared in Russian science, the use of which gives a synergistic effect, for example: engineering, business process reengineering; derivatives and others. At the same time, issues relating to the information support of the management mechanism of the territory's investment strategy have not been fully investigated.

Currently there is no single, universal method of analyzing the investment attractiveness of the territory. Most of the techniques are based on mathematical, expert or scoring estimates. At the same time, the set of indicators characterizing the region investment attractiveness does not coincide in various methods. In foreign practice, a wide range of indicators is used to form the ratings of the most investment-attractive countries (regions), in particular: factors of instability (volatility of real GDP growth, inflation), financial development of countries, government efficiency, business environment, access to potential sales markets, human potential, tax regime, transport infrastructure, the presence of transnational corporations, innovative, scientific and educational potential.

For example, according to the assessment of the Expert RA rating agency, the Kabardino-Balkarian Republic in 2017 was attributed to the regions of the penultimate 3C2 group, which are characterized by "insignificant potential - high risk". The investment climate in the region cannot be called favorable. There is a tendency to increase investment risks (especially criminal and social) while reducing financial, production and institutional capacities.

Analyzing the investment potential, it should be noted that it increased by 3 positions - from 65 to 68 and amounted to 0.489 points in the all-Russian potential, which is less by 0.026 points in 2016. Among the components of the investment potential, infrastructure, natural resource and labor potentials have a positive effect; and the production, financial and institutional potentials have a negative effect. The rank of the investment potential of the Kabardino-Balkarian Republic has remained steadily low over the past five years.

The investment risk increased from 77 to 79 and amounted to 0.402 points in the all-Russian risk, which is less by 0.013 points in 2016. Among the components of investment risk, a low level of environmental risk had a positive effect, while criminal, social and financial risks were consistently high.

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In these conditions, it is required to develop a model for assessing the investment attractiveness and economic stability of the region and, further, based on the obtained estimates, the formation of a set of measures to improve the investment climate, which will attract the interest of Russian and foreign investors.

3. Research Questions

The subject of study is the problem of developing a model that allows assessing the investment attractiveness and economic stability of a region based on a passive investment strategy. In the process of developing a model, there is the task of considering key factors of sustainable development for all territories (general economic, institutional, political risks, the state of the financial and credit and tax system, demographic potential, purchasing power of the population, etc.) and specific factors (tourist flows, leading sectors of the regional economy, transport and social infrastructure, budget subsidies, etc.).

To solve this problem, it is necessary to form a system of the most informative, quantitatively measured indicators, with the help of which it is possible to describe the investment potential of the problem regional economy. Examples of indicators describing financial and economic criteria are expenses in R & D, investments in fixed assets, the cost of financial leasing contracts, etc. Social investments characterize such indicators as the number of computers per 1000 inhabitants, the number of students, the number of Internet users, etc. Demographic parameters of investment activity can be estimated using indicators of fertility and mortality, life expectancy, survival age, migration flow, etc. It should be considered that there are investment factors that are difficult to quantify. In this case expert assessment methods, surveys, linguistic and fuzzy systems for their actualization should be applied (Jennings, Greenwood, Lounsbury, & Suddaby, 2013).

4. Purpose of the Study

In an information intensive society, the innovation and investment potential of economic development is largely determined by ideas, knowledge, technologies, competencies, information resources that ensure the achievement of investors' goals quickly and reliably, with minimal risks. In these conditions, the categories of "potential", "risk", "knowledge", "innovation", "investment", and "goals" are systemic, emergent in nature (Rakhimov, 2008). They are difficult to formalize and to estimate, and if they are to be estimated, then often with a "superposition of noise".

The solution to this problem can be the development of infological, mathematical models with the identification of integral indicators (indicators of investment attractiveness) and their subsequent use in the forecast of passive investment indices. Such parameters implicitly reflect both risks and investment potential (Smirnova & Zhukov, 2010), but, most importantly, help to implement the taxonomy of investment objects according to their investment potential. Investment potential determines needs and opportunities of potential investors. The ratio of investment potential and investment capacity determines the "coverability" of investment needs. For example, if an object has insufficient investment attractiveness, then it will most likely not attract enough investment volume for its potential or it will lose on commission, attracting high-cost funds.

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Any investment process considers the time lag. The specific value of this lag is identified expertly, analytically, or heuristically, considering the intensity of external factors. There is a need for a systematic analysis of the region activities with changes in the environment, taxonomy, classification of environmental factors, identification of the relevant system of indicators, and their intensities.

The task is difficult, mainly due to the lack of representative official statistics. There is no set monitoring system for the investment environment, as well as relevant analysis tools, for example, cognitive, allowing to determine the type of investment situation (stable, poorly stable, unstable, crisis, etc.).

5. Research Methods

To model a system, systems analysis methods are used, for example, decomposing it into subsystems, identifying a control subsystem that provides not only solutions, but also structural activity, the growing role of passive control mechanisms. Simulation procedures should consider the integral links of the system structures and its subsystems. In the study of the system, it is analyzed using the methods of evolutionary economics, mathematical methods (least squares, taxonomy, optimization, etc.), and investment analysis.

Consider the *i*-subsystem of the system *S*, the vector $x^{(i)} = (x_1^{(i)}, x_2^{(i)}, ..., x_{n_i}^{(i)})$ of basic factors (relevantly describing, affecting the functioning of the subsystem) and the functional $f^{(i)} = f(x^{(i)})$ of subsystem activity (passivity). For system *S*, we similarly introduce the vector of its state *x*, the system activity $f(x)$ and the potential *P*.

If we consider the control subsystem, then, as in technical systems, it makes sense to speak not about the activity of the system, but about its “fatigue”, emphasizing that this is only a figurative comparison, since the investment processes are more complex. It is important to identify the activity functional, its parameters (for example, the integral parameter of self-regulation).

In the one-dimensional case $(n = 1,\ x = x(t),\ 0 < t < T,\ 0 < x < X)$ it is demonstrated how to determine the evolutionary potential of investment activity in the context of a problematic regional economy.

If we assume the renewability of the investment flow in the environment with the pace according to the law $\nu = \nu(\tau)$, and the coefficient of investment attractiveness (activity) equal $p = p(\tau)$, then the evolutionary potential can be determined (Kaziev, Kazieva, & Kaziev, 2016) in the form:

$$P = \int_0^T \nu(\tau) \exp\left(\int_0^\tau \rho(\omega) d\omega\right) d\tau . \qquad (1)$$

In this case, the higher the rate of renewal, the higher the evolutionary potential, and vice versa. If the evolutionary potential is less than one, then regardless of the investment at the initial moment, the value of the investment will decrease.

It is important to identify quantitatively the factors of increasing investment attractiveness, their permissible boundary and optimal values. Especially in a “problem” region, where setting priorities,

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developing and implementing anti-crisis programs strongly influences the evolutionary investment potential. Investors do not want to go to problem regions (Anokhin & Schulze, 2008).

The following system of basic parameters is proposed for situational modeling of the evolutionary investment potential of the regional economy. We classify them as follows:

natural (volume, ratio and efficiency of investments in land, water, raw materials, recreational and other resources of the region);

financial and economic (dynamics and efficiency of investments in the industrial and non-industrial sectors of the economy, investments in the region's infrastructure provision, etc.);

demographic (dynamics, structure and efficiency of investments aimed at improving the demographic situation - an increase in birth rates and a decrease in mortality rates, an increase in the duration and quality of life, optimization of pension load indicators, etc.);

production (volume and efficiency of investments in the main and working capital, in the upgrading of skills and productivity of industrial personnel, in the automation and rationalization of production processes, etc.);

social (size and dynamics of investments associated with the intellectualization of labor, approaching individual and social welfare installations, information and public openness, reducing unemployment, poverty and uncontrolled migration, efficiency of social services, improving the crime situation in the region, etc.);

educational (volume, structure and effectiveness of investments related to the modernization of the educational system, expanding the range of educational services and improving their quality, developing and introducing modern systems and methods of teaching, etc.);

scientific and technical (volume, structure and efficiency of investments related to the implementation of the achievements of scientific and technological progress in the region, support of innovation-active organizations, commercialization of scientific, technical and innovative developments, etc.);

environmental (volume, dynamics and structure of investments in projects aimed at reducing environmental threats, risks of pollution, increasing the efficiency of environmental measures, etc. (Galindo & Méndez, 2014).

After the formation of a system of indicators, the evolutionary modeling of the investment potential is carried out, its integral assessment is given, and the elasticity of investment activity indicators is determined. For example, in the way, as it was done in the works (Kaziyev, Kaziyeva, & Kaziyev, 2016).

6. Findings

A model for assessing the investment attractiveness and sustainability of the regional economy is proposed. It is based on a generalized Cobb-Douglas production function (Hutchinson & MacArthur, 1959):

$$F = F_0 \prod_{i=1}^{n} \left(\frac{x_i(t) - x_i^{\max}}{x_i^{opt} - x_i^{\min}} \right)^{\beta_i(t)} \left(\frac{x_i^{\max} - x_i(t)}{x_i^{\max} - x_i^{opt}} \right)^{-\frac{\beta_i(t)(x_i^{\max} - x_i^{opt})}{x_i^{opt} - x_i^{\min}}}, \qquad (2)$$

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where F_0 – initial level of investment attractiveness, *n* – number of model main factors, $x_i(t)$, $x_i^{\max}$, $x_i^{\min}$, x_i^{opt} – *i*-factor and its maximum, minimum and optimal values for investment stability, *t* – time (calculating period), $\beta_i(t)$ – importance of *i*-factor, a parameter that determines its contribution to ensuring investment attractiveness and economic stability. The parameter identified by statistical and expert data $\beta_i(t)$ reflects the self-regulation capabilities by the *i*-factor.

The model can emphasize the type of region by basic investment parameters. For example, for the economy of Kabardino-Balkaria, we offer the following system of variables $x_i(i = 1,2,...,20)$:

volume of attracted domestic investments (million rubles);
volume of foreign investments (million rubles);
number of able-bodied population (thousand people);
average annual growth rate of GRP (%);
retail sales per capita (million rubles);
rate of fixed assets renewal (%);
volume of commissioned construction objects (thousand buildings);
growth rate of population real incomes (%);
energy intensity of GRP (kg of coal equivalent / 10 thousand rubles);
crime rate (crimes / thousand people);
growth rate of number of high-performance jobs (%);
population with income below the subsistence level (thousand people);
migration of able-bodied population (thousand people);
education expenses (million rubles);
health care expenditures (million rubles);
volume of information services provided to the society (million rubles);
gross value added of the tourist industry (million rubles);
expenses for environmental protection, ecology (million rubles);
regional budget subsidies (%);
volume of innovative goods, works, services (million rubles).

In the model for each factor the coefficient (pace) $\beta_i(t)$ is usually unknown and should be identified either by the totality of the selected factors or by their clusters (by considering sub-models, for example, a general economic or tourist cluster). In the short-term forecasting of investment potential, all the parameters $\beta_i(t)$ can be considered constant. Then, using the least squares functional

$$\Phi(\beta_1, \beta_2, \beta_m) = \sum_{i=1}^{m} (\ln F(t_i) - f_i)^2 \Rightarrow \min, \quad (3)$$

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where m – number of considered factors, (above $m = 21$), f_i –data, as well as a sufficient criterion for the optimum of this quadratic form, the values of the parameters β_i can be identified by the following system of equations:

$$\frac{\partial \Phi}{\partial \beta_i} = 0, \quad i = 1,2,..., m. \tag{4}$$

After identifying the model, it is suitable for preparing a short-term (if the conditions are stable - and for the medium-term) forecast of the region investment potential, based on a solution (for example, using the square root method modified by the Gauss method) of the normal system of least squares equations:

$$F(t) = F_0 \exp \sum_{i=1}^{m} \beta_i \ln A_i(t). \tag{5}$$

where $A_i(t)$ – input form (Shirshova & Dement'yeva, 2015).

The proposed integral model can be used to assess the region investment, taxonomy and ranking of regions according to the level of investment activity. In addition, it considers that a consistent increase in the amount of investment is not sufficiently inefficient, and the factors (sub-models) are limited in scope. Efficiency is determined by the interaction and interconnectedness of factors; the model should consider the synergistic effect of such interaction and the self-regulation of investment processes.

The distribution of points is set expertly, for example, by the Delphi method (brainstorming, commission, court). It is not informative enough, and it does not fully classify the group. Therefore, e the concept of amplitude and importance is introduced (Hallward-Driemeier & Smith, 2005).

Amplitude is a measure of the investment readiness of a system for a given factor. Importance is a measure of each factor significance in a model. It is required to separate the actual data (amplitudes) from the subjective assessments (importance) in order to obtain the most objective assessment (relatively independent of experts). The dimension problem (more precisely, measurements) is resolved by normalization and scaling.

Simplified classes can be considered: absolute unattractiveness (crisis), relative attractiveness (for individual main factors), attractiveness (for all key factors), full attractiveness (for all factors). In the work, a system of "positive - negative indicators" and weights of investment attractiveness was applied for the Krasnoyarsk Territory, for example, for GRP per capita - weight 0.4, for paid services per capita - 0.6, for the share of economically active population - 0.3, for the share of pensioners - 0.05, for average per capita incomes - 0.4.

For the proposed model, the quantitative and qualitative levels of classification is determined. Rating marks are given in brackets using a nine-point system (Jones, Coviello, & Tang, 2011):

complete (unconditional, absolute) unattractiveness (0);

strongly pronounced unattractiveness for all factors (1);

pronounced unattractiveness for all key factors (2);

unattractiveness for some key factors (3);

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poorly expressed unattractiveness for non-key factors (4);

poorly pronounced attractiveness for non-key factors (5);

attractiveness for some key factors (6);

pronounced attractiveness for all key factors (7);

strongly pronounced attractiveness for all factors (8);

full attractiveness (9).

Thus, the investment potential is determined by a small number of factors for which grouping can be performed according to the criteria of investment activity (passivity) and attractiveness, investment risks, investment efficiency (ratio of activity to potential) and use (ratio of activity to attractiveness).

The only possibility of integral accounting of all these diverse criteria is through self-regulation measures $\beta_i(t),\ i=1,2,...,m$ and investment potential modeling.

It should be borne in mind that the risks that always reduce the dynamism of capital are considered when passively investing. Characterized by maximum risks with low commission, profitability, low dynamics, infrequent changes in the formed investment portfolio and frequent tracking of the dynamics of market indices.

The integral weighted average risk of investment can be defined as:

$$R=\frac{\sum_{i=1}^{n}\sum_{j=1}^{m} z_j R_{ij}}{nm}, \qquad (6)$$

where z_j – importance *j*-investment process (stage) in a risk situation, R_{ij} – risk of the *j*-event of the *i*-class (taxon) (Modigliani, Miller, 1958).

In the dynamic case, it is possible to conduct a factor analysis of the dynamics, determining the multiplicative relation (analogous to the Cobb-Douglas type utility function), with the differentiation of investments by time series $y_i(t), t=1,2,...,T$ (for example, by year):

$$y_i(t)=\delta_i y_i^{\max} I_i^q(t) I_i^p(t), \qquad (7)$$

where $y_i(t)$ – investment volume, $I_i^q(t), I_i^p(t)$ – volume and investment indices, δ_i – importance parameter (scaling).

It is important to use diversification in the interests of effective risk management, reducing their likelihood, mathematical and statistical predictability of strategy results, adaptability based on the results of predictive estimates of deviations from the target trajectory (yield curve).

A correlation and regression analysis of the impact of the of passive investments share and an identification of a parametric dependence, for example, a quadratic one can be conducted:

$$f=a_2 m^2+a_1 m+a_0, \qquad (8)$$

where f – increase in passive investments, m – their share in the portfolio, a_0, a_1, a_2 – identifiable parameters

The category of “diversity” determines the development of portfolio investment and the resulting investment risks (credit, market, currency, operational, liquidity losses, legal, inflation, etc.). The selection

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of a relevant instrument is based the principle “from simple instruments to complex ones”, for example, “deposit - government bonds - UIF - ETF” (Murphy, 2012).

It is important to have relevant measures (criteria) of diversity. In this case, we will adhere to the information-entropy approach, because information is the very reflection of diversity, and the amount of information is a measure of the diversity of the situation outcome. In the information-entropy approach, diversity is an attribute of information transfer, and the information obtained is considered a measure of removing uncertainty in the system when choosing a controlling influence (for example, when diversifying an investment portfolio). As a result of the decision, there should be only one choice. Each stage of the analysis of investment attractiveness should introduce certainty and reduce information noise.

7. Conclusion

The developed model makes it possible to adequately assess the change in the complex of factors influencing the investment attractiveness and region economic stability. The performed system analysis, the proposed model and the algorithm for its identification can be used in situational modeling of investment management, their diversification, forecasting the profitability of the investment portfolio, both at the level of a single region, and for taxonomy and ranking of organizations and regions by level of investment activity. The quantitative and qualitative levels of the state investment attractiveness of an economic object are determined.

The conclusions and generalizations can serve as source material for further scientific research on an investment strategy at the national and regional levels, sectoral planning, and forecasting the dynamics of the gross regional product based on investment growth.

However, it is necessary to consider the complexity. Situational investment analysis in the regions is complicated by the lack of an effective investment policy, effective legal measures that promote the growth of responsibility not only for tax, but investment offenses that increase the investment activity of economic entities. There is no systematic approach to making investment decisions by regional authorities, assessing inflation expectations and mismatch risks, etc.

The competitiveness of a region is determined not only by the level of its technological development, but also by its penetration into the business processes of innovative mechanisms. For an innovative project and product to be profitable, an IT-supported regional policy and infrastructure are needed, which provide complete information about the prospects for the implementation of innovations. Such information in the Russian Federation is presented as statistical indicators of innovative activities of industrial organizations in the context of regions, industries, types of ownership, etc. One of the approaches to solving this problem is to use controlling as the basis of information technology management in the region.

For example, if the functional *F(s,u),* where *s(t)* is a region’s investment activity, *u(t)* is admissible controls, u_{opt} is the optimal one of admissible, then the success of the region’s investment development is estimated by the formula

$$H = \left|(F_{\max} - F_{\min})/(F_{\max} - F_{\min})\right|, \qquad (9)$$

where

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$$F_{\max} = \max F(u_{opt}, s_{\max}), \quad (10)$$

$$F_{\min} = \min F(u_{opt}, s_{\min}), \quad (11)$$

$$t \in [0;T], \ s \in [s_{\min}; s_{\max}]. \quad (12)$$

To develop a relevant procedure, a methodology for developing investment-oriented conclusions on the sustainability of a region's state, evaluating ratings, it is necessary to use unconventional, but already popular methods, tools: odd sets (logic), catastrophe, situational modeling, neural networks, etc. The authors attempted to build such a technique.

Acknowledgments

The article is published in the framework of research under the grant of the Russian Foundation for Basic Research, project No. 17-02-00467-OGN.

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