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INVESTMENT RISKS IN THE ASSESSMENT OF THE LEVEL OF ECONOMIC DEVELOPMENT OF THE REGION

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Abstract

The relevance of the problem under investigation is defined by the rationale for the causes of the negative (and positive) impact of uncertainty and risk on the agrarian production of the region. The topicality of the paper is also determined by the problems of developing such methods for evaluating investment attractiveness, which allow to avoid a significant loss of information for the investor. The article aims to study the basic concepts and stages of the multicriteria process and the dynamic processes of the agricultural sphere. The main approach to the study of this problem is the use of sign, weighted sign and functional sign graphs, classical and multicriteria optimization of the construction of an economic and mathematical model for determining investment risk in the system for assessing the level of economic development of the region. The optimization is carried out under multicriteria conditions. The results of the research show the level of economic development of the region with the focus on the risk and uncertainty factors in the conditions of multicriteria approaches and the usage of sign graphs. At the same time, the analysis of various mathematical models applied to the study of investment risk dynamics has shown that it is advisable to use sign, weighted sign and functional sign graphs. The materials of the article can be used in the system of assessing the level of economic development of the region.

Keywords

Investments – Risks – Factors – Correctly – Regulation – Tools – Graphs – Sign graphs

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Introduction

The analysis of the nature of the investment processes, in particular of their sustainability, as well as the involved investment-related risks arising in the socio-economic systems under the influence of various kinds of disturbance is an important factor in making a decision about the suitability of the given objects for investment.

A topical issue is the development of such methods for assessing investment attractiveness, with the use of which there is no significant loss of information. Investment attractiveness is characterized by a utility function, i.e. an investor should evaluate every pair of compared objects on the principle of "better", "worse" or "equivalent." In other words, any economic-mathematical model proposed for the analysis of investment attractiveness estimation should be an optimization model. At the same time, this optimization is carried out under multicriteria conditions[1].

In the theory of classical and multicriteria optimization, the construction of a mathematical model begins with a formal strict definition of the set of admissible solutions X = {x}. The symbol X denotes the set of all agricultural enterprises offered to the analyst to justify the assessment of their investment attractiveness. The symbol x stands for the name of the enterprise.

Methodology

The main component of the multicriteria model is the vector objective function (VOF)

$$F(x) = (F1(x), F2(x), \ldots FN(x)), \quad (1)$$

consisting of maximized criteria

$$Fv(x) \rightarrow \max, v = 1N1, N1 \leq N, \quad (2)$$

and possibly, minimized criteria

$$Fv(x) \rightarrow \min, v = N1 + 1, \ldots, N. \quad (3)$$

Minimized risk criteria, for example, can be considered as criteria (3).

Discussion

There is a sufficient number of works[2] which focus on the risk and uncertainty factors. These works use a wide variety of risk analysis and management methods. For example, for the analysis of risk factors, well-known methods of comparison are used, such as index, balance, functional-cost, factor analysis and others. But, basically, they are focused on the processing of the input data presented in the quantitative measurement scales. At the same time, in the situation of uncertainty and the influence of a large number of internal and external factors, especially the environmental ones, there arises a need for the search and testing of some new methods for qualitative risk analysis. Under these conditions, there is an increase of the role of analysis in scales of the order allowing to make more clear

[1] E. V. Popova, Mathematical models and methods of risk assessment of social and economic processes. Ph. D. thesis (Cherkessk, 2002) y F. M.-G. Topsahalova, Theoretical and methodological bases of an estimation of investment appeal of agrarian sector. Ph. D. thesis (Stavropol, 2006).

[2] N. I. Kostyukova, Graphs and their application. Combinatorial algorithms for programmers (Moscow: Internet-University of Information Technologies: Binom. Laboratory of Knowledge, 2016); V. V. Lyuktyukhin, Working out of models and methods of an estimation of investment activity of industrial enterprises of region (On an example of the Ryazan area). Ph. D. Thesis (Ryzan, 2004) y O. Ore, Graphs and their application. №87. Ed. Correction. and noun. Add (Moscow: Lenand, Editorial URSS, 2015).

conclusions about the stability of the investment process and about the risks associated with it. These conclusions are based on the information about the structural features of the system of interaction of an enterprise with the external environment, as well as with the regional and federal authorities.

Investment risk analysis based on methods of stability testing involves the development of an investments script in the most probable or most dangerous conditions for each enterprise. Investment process in this case is stable and effective, if in all the situations considered the interests of its participants are respected, and the possible adverse effects are neutralized.

Financial risk is defined as the degree of uncertainty which depends on the ratio of debt and equity: the more borrowed funds, the higher the financial risk.

Analysis of various mathematical models in the study of investment process dynamics has shown that it is efficient to use sign, weighted sign and functional sign graphs.

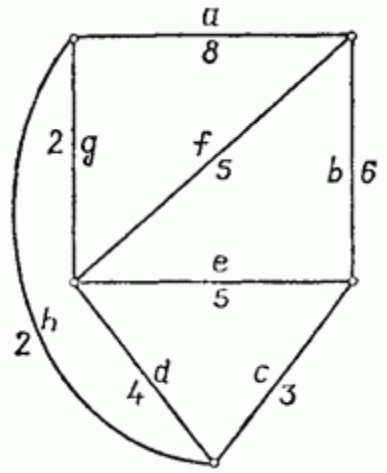

Fig. 1
Weighted graph

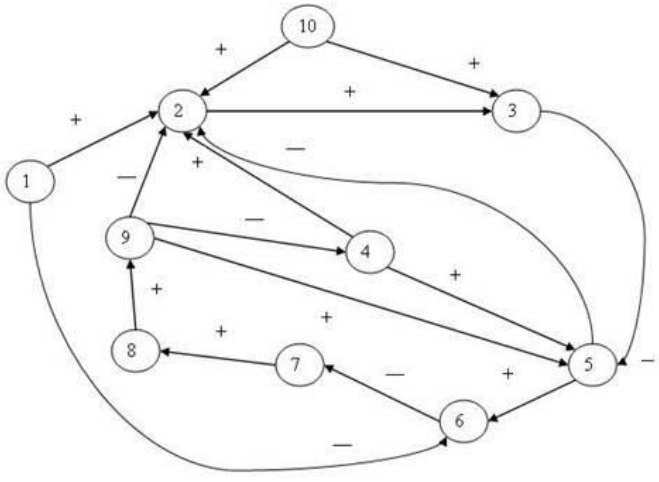

Fig. 2
Sign graph

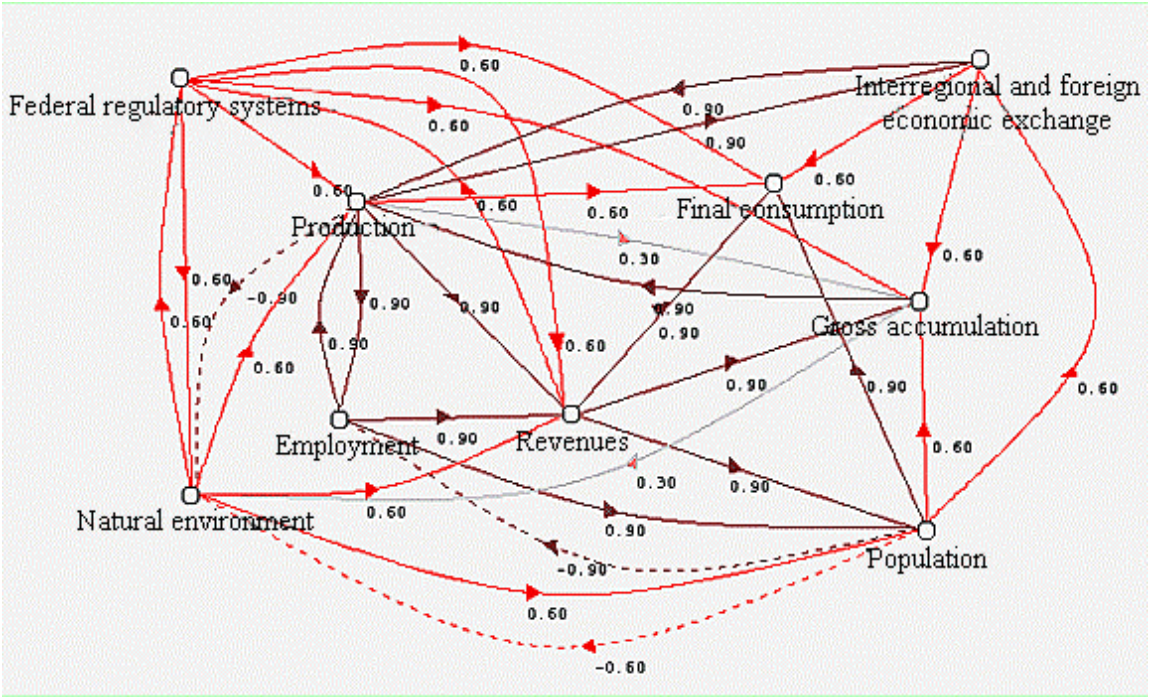

Fig. 3
Weighted sign graph

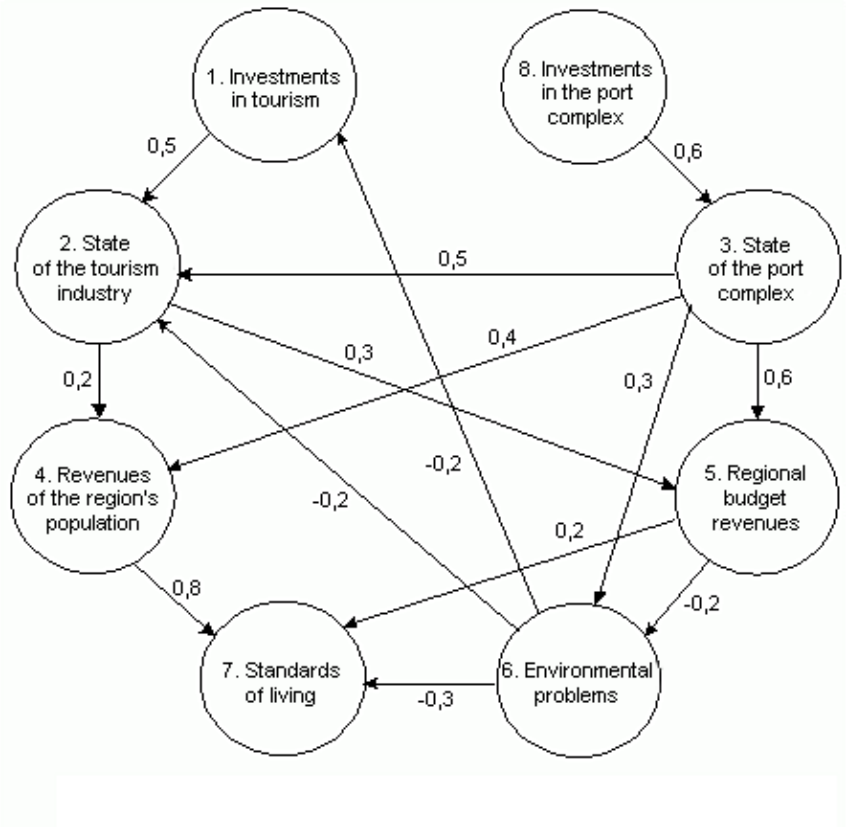

Fig. 4
Functional graph

In connection with this, the possibility of the use of the sign digraph method proposed by a group of authors from the Institute of Control Sciences (ICS) of Russian Academy of Sciences (RAS) is considered. Its application is especially useful, because it avoids the high laboriousness arising from the need to consider a large number of significant and at the same time heterogeneous factors, while giving an opportunity to construct adequate graph risk models based on dependencies of a qualitative type. It allows to work with data of both qualitative and quantitative type. The extent of the use of quantitative data may increase depending on the possibilities of quantitative assessment of the interacting factors in the iteration cycle. At the initial level, the information about the studied socio-economic system (situation) is collected. Then the concept and assumptions concerning the system (situation) are formulated in a mathematical language and a mathematical model is formed, which allows one to evaluate the dynamics of behavior (development dynamics). Modeling is seen as an attempt, first of all, to remove the uncertainty that inevitably accompanies the forecasting of the system development, and, second of all, to suggest a way of transforming the process of uncertainty into a controlled process. This uncertainty can be removed with the help of the information concerning the different variants of the system development that was accumulated previously or with the help of if the scientific research or the experts' personal experience.

There are two categories of uncertainty:

1. External uncertainty, i.e. factors, which are only to a very small extent under the control of the decision-maker.
2. Internal uncertainty, i.e. factors, that are absolutely out of control of the party in charge on the basis also completely, but over which the decision-maker can exercise a certain influence.

A mathematical model of sign, weighted sign and functional sign graphs is used to enhance the mathematical model of digraphs. In addition to the digraph basis, the model includes the following components:

1. A set of parameters of the vertices $V = v_i$, $i \leq N =]|X|]\}$. Each vertex $x_i \in X$ has a corresponding parameter $v_j \in V$.
2. The functional of the transformation of the arcs F(V,E), relating each arc to a sign, a weight or a function.

If the functional $f(v_i, v_j, e_{ij}) \in F(V,E)$ has the form of

$$\mathrm{f(vi, vj, eij)} = \begin{cases} +1 \text{ if } vi \text{ increase (decrease) leads to } vj \text{ increase (decrease);} \\ -1 \text{ if } vi \text{ increase (decrease) leads to } vj \text{ decrease (increase);} \end{cases} \quad (4)$$

this model is called a sign graph.

If the functional has the form of

$$\mathrm{f(vi, vj, eij)} = \begin{cases} +\mathrm{wij} \text{ if } vi \text{ increase (decrease) leads to } vj \text{ increase (decrease);} \\ -\mathrm{wij} \text{ if } vi \text{ increase (decrease) leads to } vj \text{ decrease (increase);} \end{cases} \quad (5)$$

this model is called a weighted sign graph.

Here w_{ij} is the weight of the corresponding arc (e_{ij} parameter reflects the presence of the arc (i, j));

If the functional has the form

$$f(v_i,v_j,e_{ij}) = f(v_i,v_j), \quad (6)$$

then such a model is called a functional sign graph.

The notion of the impulse and the impulse process in discrete time space is introduced on the extended digraphs. The change of the parameter v_i at the vertex x_i at the moment of the time $n \in N$ is called impulse $p_i(n)$ at the vertex x_i.

$$p_i(n) = v_i(n) - v_i(n-1). \quad (7)$$

The value of the parameter at the vertex x_i is determined by the following:

$$v_i(n)=v_i(n-1) \sum_{j=1}^{N} f(vi, vj, eij) pi(n-1) + p_i^0(n). \quad (8)$$

Here p^0_i is the external impulse introduced to the vertex x_i in the moment of time n while $j \neq i$. From the finite-difference equations, it is easy to obtain an equation for the impulse in the process under study:

$$p_i(n) = \sum_{j=1}^{N} fi(vi\ vj\ eij) pi\ (n-1) + p_i^0(n) \quad (9)$$

Here, the concept of even and odd cycle is used. An even cycle has a positive product of the signs of all its arcs, while an odd cycle – a negative product. Even cycle is the simplest model of the structural instability, since any change in the parameter in any of its vertices results in an unlimited growth of the parameter module of the vertices of the cycle, while the change of the parameter of any vertex of an odd cycle leads only to an oscillation of the vertex parameters.

A sign graph is called absolutely stable for a given impulse process model, if each its vertex is impulse stable in this process.

The impulse process is called autonomous, if

$$p_k^0(n)=0, \forall\ n \geq 1, \ \forall\ x_k \in X. \quad (10)$$

The impulse process is called simple, if

$$\left(\sum_{k=1}^{N} p_k^0(0) = 1\right) \& \left(p_k^0(m)\right) = 0, \forall m \geq 1, \forall x_k \in X). \quad (11)$$

The vertex of the sign graph is impulse-stable for a given impulse process if the sequence of absolute values of impulses at this vertex is limited. Thus, the notion of resonance was introduced to describe the phenomenon of instability in simple impulse processes, arising from the effects of feedback.

The sign digraph method is a powerful means of this structural modeling. When solving a task, one should define the set of vertices subject to possible influence for the achievement of the desired result. It is also necessary to define the nature of the influence. It is often the case that changes in one of the components of the social and economic system entail a certain impact on the other components of the data in such a way that some of them are impacted at once, while others after a certain time interval. In terms of sign graphs, it means that the impulse goes from the initial to the final vertex not in one tact of modeling. In fact, this means there are several arcs between the vertices. The product of the arcs gives the weight value of the initial arc. Consequently, the impulse while moving from vertex to vertex passes through the arc not every time but only with an interval of the given number of modeling cycles.

Thus, it is possible to move from the traditional modeling tasks to the solution of an inverse problem: what needs to be done to achieve the necessary behavior of the system? The solution of this task makes it possible to move from forecasting the behavior of social and economic system to planning the actions for its management. For this purpose, vertices-objects and vertices-subjects are selected from a set of vertices. A vertex-object is the vertex the change of which we want to control at a given time interval. A vertex-subject is the subject, by influencing which we want to implement the controlled changes. This influence consists in introducing external impulses to the vertex. When choosing subjects of management, it should be noted that these subjects can be only real management tools, and only the available resources can be chosen as a program of external influences.

As the basic processes describing this mechanism for its qualitative analysis, it is proposed to consider the following:

- Subsystem "Region".
- Change in the quality of the environment.
- Changes in the quality of life.
- Changes in payments to the budget.
- Changing the risk models for an emergency situation.
- Subsystem "Enterprise".
- Ensuring the current profitability of production.
- Implementation of technological re-equipment programs.

By way of example of the interaction of enterprises with the region, it is proposed to focus on processing enterprises that actively use the region's natural resources (water, air, land and other ecological “components”). The risk of investment in these enterprises is largely related to the effectiveness of environmental risk management in the region. The following items are proposed as parameters for this system:

Q - quality of environment;
R - increase in the number of people with a higher standard of living;
W- level of payments to the regional budget;
I - pollution level of the environment;
H - payment for environmental resources;
N - growth of profit;
C - level of competition;
P - implementation of programs of technological re-equipment;
M - exceeding the permissible level of emission limits and emergency situations;
E - the efficiency of using the environmental resources of the region.

The interplay of processes, determined by socio-economic and natural laws, is reflected by the arcs with the corresponding signs. When constructing the model, it is necessary to take into account the temporal relations between the basis and generated impulse processes. In this example, for the sake of simplicity, the transmission time of the impact is equaled to one. The digraph cycles being odd, there is a basis for assuming that the system is stable. However, the cycles can interact, since there is a bridge.

Results

Based on the approaches of various authors to modeling and assessing the investment attractiveness of enterprises presented below, the following conclusions can be formulated. In principle, there is no single indicator that would adequately assess the investment attractiveness of the enterprises in question at least relative to each other and at the same time take into account all the uncertainties. When trying to generalize multiple indicators into one indicator, there is inevitably a loss of information that is very important for the analyst as well as for the decision-maker. The materials of the article are of value for students studying disciplines: "Investment Analysis", "Organization of Investment Financing", "Investments in Agroindustrial Complex", "Economics of Agriculture". The indicators of financial and economic risk should be considered as the most important indicators, at least in relation to the agro-industrial complex located in the zone of risky farming.

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