

Evaluation of Investment Attractiveness of the Enterprise Based on its Entropy

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Abstract: The interrelation of investment attractiveness and entropy has been studied in the article. The main reason of the origin of entropy, a so-called bifurcation point, has been indicated. The importance and necessity of the research of such an economic category as entropy have been grounded. On the basis of the analysis of definitions in the previous articles the author suggests the own definition of entropy in terms of economics. The method of estimation of investment attractiveness based on its entropy has been described. The matrix of interpretation of the entropy and investment attractiveness values has been considered.

Key words: Entropy • Bifurcation point • Investment attractiveness • Method of 'critical points'

INTRODUCTION

The study of modern economic processes allows us to make a conclusion that the humanities comprise fundamental laws the use of which will give us an opportunity to more accurately analyze economic processes within the enterprises and forecast their further occurrence.

An enterprise is an open system which includes the processes of resource exchange with external environment. Such a system is called non-isolated system. The system is gradually changing under the influence of external factors. In thermodynamics this process is called entropy. The term 'entropy' was coined in 1865 by Rudolf Clausius [1]. This concept has been used in economics recently. The effective activity of the enterprise is impossible without the quality and concerted management process of economic activity of the enterprise or suppression of entropy. It is precisely the enterprise management from inside that forms its state in market environment. The effectiveness of management activity is defined by the state of entropy within the enterprise, that is by the chaos degree which predominates in the given system and influences the activity of the system in whole and its each unit in particular.

MATERIALS AND METHODS

The methods of theoretical generalization, dialectics, logic, systematic, historical-economic approaches have

been used while analyzing the scientific achievements in the sphere of evaluation of investment attractiveness and entropy and while systematizing the existing approaches to such economic categories as 'entropy' and 'bifurcation'. The methods of expert information analysis and regression and correlation analysis have been used while developing the methodology of evaluation of investment attractiveness and entropy.

The invested resources is the main component of enterprise development, however, the influence of the factors of external environment provokes the increase of enterprise entropy. Considering the interrelation of these factors, the evaluation of investment attractiveness allows us to have a well-grounded opinion about investment effectiveness.

To describe the process of entropy appearance within the enterprise it is necessary to consider the concept 'bifurcation point'. Bifurcation from Latin means division in two. The concept 'bifurcation' was first introduced by the famous mathematician Henri Poincaré at the beginning of the XX century, the bifurcation theory was later applied in other fields of science such as physics, sociology, economics and etc. The study and use of bifurcation principles give an opportunity to make a detailed research of any system, an enterprise as well, to forecast the character of new changes and evaluate the state of the system. Investment activity is an example of bifurcation, in this connection the author has analyzed the modern definitions of this concept. The analysis of various sources has shown that scientists have different

attitudes to the economic category 'bifurcation point'. Some of them like Gruschinskaya N.M. [2], Voronkova V.G. [3], Akimova A.T. [4], Shkurkina V.M. [5] consider it to be a critical moment for the enterprise, some scientists like Samofalov Yu. Ye. [6], Cell-Mann M. [7] regard it as an opportunity for development and the third group of scientists which includes Prigozhin I. P. [8], Kolesnikova T. A. [9], Osipov Yu. M. [10] think that it is the state of uncertainty at a certain stage of enterprise activity. The author has an opinion that bifurcation point is a certain moment of time during which the further fate of enterprise development is defined. At the moment of investment the effectiveness of enterprise activity can be changed in the following way: the effectiveness can be increased, reduced or it may not be changed. Everything depends on the way the administrative staff of the enterprise regulates and directs the resources and the way it responds to the factors of external action.

As there is a necessity to suppress the existing entropy in the bifurcation point, it is of great importance to study the given definition.

As it has already been defined, entropy influences and characterizes not only thermodynamic processes, but economic ones as well which is proved in the following papers [11-16]. Each enterprise can be characterized by estimating its chaos degree and this value can be used while evaluating and managing its investment attractiveness.

While building the model of evaluation of investment attractiveness based on entropy (for an open system (non-isolated) or enterprise in market environment), the following principle is to be fulfilled: the structural state of the system is to aim at minimum entropy production. This principle was proved in the theorem by the Belgian scientist and Nobel Laureate I. Prigogine [8]. The systems in which the principle is considerably broken are non-optimal, less competitive and often collapse.

Entropy appears due to the fact that an absolutely isolated system does not exist in nature. There is constant exchange of resources, energy, information and financial resources between systems. This process occurs because everything in nature seeks balance, however it is impossible with the constant disintegration process of a complex system into simpler ones. There is another characteristic of an enterprise in terms of thermodynamics: entropy appears under the influence of competition for information, energy, resources and it explains the fact that some enterprises gradually change on the way to regulating their system, still others collapse and leave the market.

For the purpose of study of this concept the author has analyzed the definitions of this economic category and on their basis the own definition has been offered: 'entropy is the process of uncertainty increase of economic system as a result of deficiency or surplus of information from external or internal environment that complicates the process of enterprise management.

Both categories (investment attractiveness and entropy) have common features, as each of them depends on effective management of its own resources and shows opportunities for investors. Thus it has been determined that the state of enterprise entropy, or the chaos degree with which the main enterprise activity is performed, influences the value of the integral index of investment attractiveness. The smaller entropy, chaos or uncertainty of the enterprise is, the higher its investment attractiveness is. The state of investment attractiveness at different stages of development is calculated in the following way:

The determination of the main groups of indices of investment attractiveness evaluation by defining those which are mostly referred to in economic literature:

$$N_i = \sum_{j=1}^m j \quad (1)$$

Where N_i - number of points of i -group of indices;
 m - number of expert scientists;

$$m=1,2,\dots,n:$$

j - Number of groups of indices which are referred to in the literature under study;

$$j=1,2,\dots,n:$$

The calculation of weight coefficient of each group of indices on the basis of the obtained points:

$$k_i = \frac{N_i}{\sum_{i=1}^n N_{ij}} \quad (2)$$

Where $\sum_{i=1}^n N_{ij}$ - number of points on each group;

$$N_{ij} = N_1 + N_2 + \dots + N_m = 1; k_i \leq 1$$

The determination of weight of each index which is a component of each group:

$$A_j = \frac{A_i}{N_i} \quad (3)$$

Where A_j - number of references of each index in literature;

$$A_j = 1, 2, \dots, n$$

$$A_j \leq 1, \sum A_{i1} + A_{i2} + \dots + A_{in} = 1$$

The calculation of total weight coefficient of each index:

$$W_i = k_i * A_j \quad (4)$$

Where $W_i \leq 1$.

The interval ranking of possible values of the calculated indices on the 3-point scale:

$$R_i \in [R_{i\min}; R_{i1}] = 1; R_i \in [R_{i1}; R_{i2}] = 2; R_i \in [R_{i2}; R_{i\max}] = 3$$

Where R - calculated value of investment attractiveness index;

$R_{i1}, R_{i2}, R_{i\max}, R_{i\min}$ are determined by the expert who evaluates the investment attractiveness on the basis of calculated coefficients and normative values.

The calculation of relative deviation of actual value of each index multiplied by the obtained point (on the 3-point scale) from the planned or maximum possible index in points (I_{ijn}):

$$I_{ijn} = b_{ijnf} / b_{ijnp} \quad (5)$$

Where b_{ijnf}, b_{ijnp} - deviation of actual or maximum possible value.

The calculation of entropy index of j-enterprise in n-period by using the formula:

$$E_{ijn} = -I_{ijn} * \log_2(I_{ijn}) \quad (6)$$

The calculation of integral investment attractiveness index of the enterprise:

$$I = \sum_{n=1}^n W_i * R_i \quad (7)$$

Where n - number of indices composing the integral investment attractiveness index.

The interpretation of the obtained results, that is the ranking of enterprises according to the value of investment attractiveness and entropy index by using the dependency matrix:

$$I_{place} = I_{\max} \dots n \quad place = I_{\min}$$

To define the level of impact on the enterprise all the calculated values of entropy and investment attractiveness are to be analyzed on the basis of the method of 'critical points'. It gives an opportunity to define the dependence between the indices. The dependency matrix is presented in Table 1.

According to the matrix 4 zones of investment attractiveness have been formed














- The zone  is possible only in theory and is hardly probable in practice. It is characterized by high investment attractiveness and high entropy or by low investment attractiveness and low entropy which is impossible with inversely proportional dependence.
- The zone -the enterprises which are in this zone are the most investment-attractive ones, in comparison with the other enterprises which are not in this zone, that is why such enterprises are able to guarantee the most profitable terms and high results of investment operation both for the enterprise and the investor.
- The zone  includes enterprises which can guarantee middle effectiveness level from the invested resources as there is some irregularity and non-coordination in their work and all these factors slows down the development, flexibility and response mobility to the changes of the enterprise external environment.

Table 1: The dependency matrix of entropy and investment attractiveness

| Entropy level | Result of calculated indices | | |
|----------------------|---|--|---|
| | High | Middle | Low |
| Absence of entropy |  |  |  |
| Middle entropy level |  |  |  |
| High entropy level |  |  |  |

- The zone  is the riskiest one for investors. The enterprises which are in this zone cannot guarantee the profit earned from the investor's investment operation due to high entropy level and low investment attractiveness. However, the involved investment resources can positively influence the enterprise effectiveness and the probability of transition to another zone increases.

Thus, the use of this matrix leads to more grounded decisions and effective investment operations for the investor. The enterprise will be able to estimate the level of its investment attractiveness to find the spheres of activity which require interference in order to reduce entropy.

Modern conditions of enterprise management require the attraction of investment resources. Low investment attractiveness is a consequence of many reasons. The main factors is country's unstable political situation, imperfection of legislation, lack of innovation and technology adoption in industry, complex bureaucratic apparatus, bribery, unstable economic environment and obsolete equipment. To solve these problems the author suggests turning to fundamental laws of nature in order to find the answers to the questions of effective use of resources within the enterprise with the aim of strengthening the investment effectiveness. The second law of thermodynamics says that the entropy of a non-isolated system increases, that is without the effective interference into the process of enterprise management its irregularity increases. Therefore the author has formulated the assumption that effective management of enterprise entropy will lead to the increase of its investment attractiveness.

CONCLUSIONS

As the entropy question attracted the attention of many famous scientists, the author proves the importance of entropy evaluation and offers to take it into account in enterprise management. Based on the above mentioned method, the evaluation of investment attractiveness of the enterprise based on its entropy gives an opportunity to define the spheres of enterprise activity which require close administrative control. The further research is to be aimed at the search of the method of entropy evaluation with the same number of indices for all enterprises.

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