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DIAGNOSTICS OF INNOVATIVE BASIS OF NATIONAL ECONOMY DEVELOPMENT

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Key words:
diagnostics, efficiency, development, system, crisis management, constancy, risk.

The article presents the results of research by scientists from various scientific schools that is devoted to the impact of innovative processes on the development of the national economy. It presented an algorithm for the diagnostics the stability of functioning of large-scale economic and production systems at the national level in the long term, founded a subject of diagnostics in anti-crisis management,proved that the effective diagnostics can greatly improve the efficiency of development of the socio-economic system, proposed economic and mathematical tools, and concerning the diagnostics of these processes – this makes it possible to determine the essential components of a systematic approach for the development of methodological foundations for the study of the sustainable development of large-scale (national level) socio-economic systems, and above all, their innovative component, as a basis for ensuring long-term development.

ДІАГНОСТИКА ІННОВАЦІЙНИХ ОСНОВ РОЗВИТКУ НАЦІОНАЛЬНОЇ ЕКОНОМІКИ

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Ключові слова:
діагностика, ефективність, розвиток, система, антикризове управління, сталість, ризик.

В роботі представлені підсумки дослідження науковців – представників різних наукових шкіл, присвячені впливу інноваційних процесів на розвиток національного господарства. Представлено алгоритм діагностики стійкості функціонування великомасштабних економіко-виробничих систем національного рівня в довгостроковій перспективі, встановлено предмет діагностики в антикризовому управлінні, доведено, що завдяки ефективній діагностиці можна в значній мірі підвисити ефективність розвитку соціально-економічної системи, запропоновано економіко-математичний інструментарій, щодо діагностики зазначених процесів це дає можливість визначити істотні складові системного підходу для розробки методологічних основ дослідження сталого розвитку крупно масштабних (національного рівня) соціально-економічних систем, і перш за все, їх інноваційної складової, як базису забезпечення довгострокового розвитку.

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Statement of the problem

Dynamic transformations of social development, which today have covered the entire globalized world, require constant scientific research on the latest theoretical and methodological approaches, development of practical recommendations for diagnostics of innovative components of long-term sustainable development of the national economy.

The proposed scientific work is based on the special importance and necessity of integrating the innovation potential of large-scale socio-economic systems into a complex system set, which ensures its sustainable and effective development in the long run.

Optimization of relationships and dependencies of numerous and diverse resources, opportunities and advantages of production systems qualitatively transform and strengthen the potential of the socio-economic system of the national economy, so this research is timely and relevant.

Analysis of recent researches and publications

The theoretical and methodological basis of the study the results of which are contained in this work, were the fundamental scientific achievements of famous scientists, in particular I. Bersutskiy [11], V. Zabrodskiy [6], N. Kyzyma [6], N. Lepa [11], R. Nelson [10], V. Rapoport [4], S.G. Unter [10], however, its relevance and significance require constant expansion of the existing theoretical and methodological basis, adaptation of existing developments and practical recommendations to the realities of social development, which are constantly transformed and changed.

Objectives of the article

The purpose of this work is to study the theoretical foundations of diagnostics of innovative principles of long-term development of the national economy.

The main material of the research

The development of the national economy on an innovative basis in the long run must be successfully and effectively diagnosed.

Economists use the term "diagnostics" in the management of the socio-economic system in various meanings.

Thus, according to Lytvak B.G., "diagnostics – the establishment and study of signs that determine the development of the situation and prevent unwanted deviations in its development" [8].

Iuksviarav R.K., Habanuk M.I., Leimani I.A. considered that "in the process of diagnosing the problems of the organization and the reasons for their occurrence are determined" [9].

Aunapu F.F. noted that "diagnostics – a method of analyzing the state of the production system to identify and eliminate disparities in it that contribute to the emergence of "bottlenecks", ie "diseases" of the production organism", that is defined in [9].

Korotkov E.M. argued that "diagnostics – a method of establishing and determining the signs and causes of deformations and deviations of the object from the norm, trends, design, purpose, etc." [7].

According to Rapoport V.I., diagnostics is a managerial work to identify problems and bottlenecks in the enterprise management system [4].

Thus, the diagnostics of the socio-economic system should be understood as a method of recognizing the causes of enterprise problems.

Consider how the diagnostic method is used in the management of socio-economic systems.

It should be noted that in the practice of management of socio-economic systems, the diagnostic method is used mainly in determining the causes of the financial crisis.

Thus, it is necessary to distinguish of the most famous foreign scientists Altman E.I., Weaver W., Kolas B., who have made a significant contribution to the use of the diagnostic method in the study of the financial condition of the socio-economic system that studied in the monograph [9].

As evidenced by the authors [9], the most famous researchers which in the diagnosis of the financial situation used the method of discriminant solvency indicators were Altman E.I. (USA), Lys R., Tafler, Tishou (UK), Golder M., Konan (France).

Among the domestic scientists-economists who are engaged in a problem of diagnostics of a financial condition of social and economic systems of the enterprises, it is necessary to allocate first of all Zabrodskiy V.A., Kyzym M.O. [6].

At the stage of rapid diagnostics, the authors Zabrodskiy V.A.and Kyzym M.O. [6] determined the type of financial "disease" of large-scale economic and production systems at the national level (LEPSNL), and at the stage of fundamental diagnostics – the causes.

Both areas of diagnostics are closely related; and this connection is two-way. On the one hand, the empirical material obtained in the analysis of specific systems is needed to build models and to assess the compliance of these models to a particular class of systems.

On the other hand, the solution of theoretical problems formulated in relation to the construction of models of socio-economic systems is not only important in itself, but also expands the boundaries of empirical study of the crisis and the reasons that generating it in socio-economic systems.

Thus, the task is to build and study models of many possible, from a given point of view, socio-economic systems, regardless of their current existence.

First, this is necessaryto develop methods for solving certain problems on simple models, which sometimes have limited practical value due to a significant degree of idealization.

Secondly, and most importantly, this approach leads to the development of common methods and to the accumulation of an arsenal of tools, to some extent ahead of practical requests.

However, this approach requires the construction and consideration of a myriad of models.If we proceed from the existing classification of stages of development of the organization, then according to the cyclical development it is necessary to consider 1014 variants of models, provided: stages of development of organizations $n = 5$ [3]; types of crisis $m = 20$.

$$n^m = 5^{20} = 1014. \quad (1)$$

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Currently, a relatively small number of models of socio-economic systems are known as objects of diagnostics in crisis management. In our opinion, they can be divided into several groups depending on the degree of their abstractness, ie on which aspects of the systems have received or not received their reflection in these models.

At the same time, it would be premature to talk about creating a comprehensive classification of models of socio-economic systems in the context of crisis management.

Having studied the classifications of such models published in the literature, we have the opportunity to state that the simplest models for diagnosing the crisis of socio-economic systems do not take into account the structure of the system, ie it is assumed that the system consists of a number of unrelated elements.

In another class of models that take into account the structure of the system, they can be divided into two groups depending on explicitly or implicitlythis structure istaken into account.

In the first case, when creating a model, the actions applied to the external inputs of the system and the functional relationships between the actions and reactions observed at the external outputs of the system, depending on the state of the system, must be specified. Anyone possible for this model, the test is to determine the system's response to a given action.

In the second case, the model of the socio-economic system being diagnosed can be considered as a finite set of interconnected subsystems.

Here it is true that each element of the system corresponds to a certain reaction to the applied set of actions, which may include the reactions of other elements.

Zabrodskiy V.A. and Kyzym M.O. proposed the following schematic diagram for diagnosing the financial stability of the functioning of LEPSNL, which are presented in Fig. 1, according to the study [6]

As can be seen from Fig. 1. the process of diagnosing the financial condition of large-scale economic and production systems includes: symptom monitoring, rapid diagnosis and fundamental diagnosis of financial "disease", the final analysis of financial disease and its causes.

To create this model of socio-economic system, it is necessary to specify many elements, many possible states of the system, its structure, which reflects the relationships between the elements.

Considering the elements of the diagnosed systems, it is not always possible to identify them with the "physical elements" of the system, the set of parts of which the system consists.

Each of the elements of the system (subsystem) can cause not one but several crisis states, and if the separation of these states is part of the diagnostic task, then each such element must be considered as a set of elements.

A crisis situation in the systems being diagnosed can be caused not only by the elements of the system, but also by the disruption of the connections between them. Therefore, in our opinion, the scheme of the object of diagnosiscannot be confused with the usual functional scheme of the examined system.

The third direction of diagnostics assumes the analysis of existing diagnostic systems, revealing of principles of their construction and development of methods of the decision, an estimation of optimality.

In our opinion this direction has an important theoretical and practical significance, as it is associated with the development of criteria for informative indicators that characterize the state of the system, analysis of diagnostic methods, the construction of the appropriate diagnostic process.

At diagnosis the choice of informative signs for the description of social and economic systems becomes essential (Fig. 2).

In many cases, this was due to the difficulty of obtaining information or the cost of diagnostic testing, sometimes its search, systematization, analysis and processing.

The parameters of the elements of the system being diagnosed are not equivalent in the amount of information about its state.

Some bring information about many properties of system elements, others are incomparably less and of different quality.

A priory preference should be given to parameters that are dynamic in nature, rather than those that are stable or slowly changing. In diagnostic tasks, it is important to choose the most informative features to describe the object.

Based on these studies, we can conclude that the diagnostics is: a study of basic indicators of the socio-economic system; expert assessment of the developed measures and prospects of financial recovery and preventive rehabilitation and achievement of forecasting goals; the desire for quantitatively indeterminate and qualitatively "super-complex" levels of the socioeconomic system, which Beer S. [1] refers to as "metasystem","homeostasis" and "entelechy " of organization, and Ryan B. [12]as "the ethical world".

Metasystem levels and qualities of socio-economic systems determine the need for diagnostic as a specific way of obtaining and using information.

Beer S. [1], who studies the information provisions of Heisenberg's uncertainty principle [2] on the functioning of the socioeconomic system, believes that the human brain and the "brain" of the system equally solve the main problem of managing the diversity of the growing environment.

The proposed solution was concluded in creation an organization. Obviously, the principle of uncertainty, according to which the transfer of information, communication and control, in any system, indicates the limit of measurement accuracy, the energy of intra-system interaction, and any attempt to improve measurement accuracy leads to a change in the object of measurement and irreversible distortion of information.

In a situation of high accuracy of measurements there is always a distorting influence of the subject of measurements – the person [5].

To assess the significance of information, we use the basic provisions of information theory [11].

According to it, to measure information, we introduce two parameters: the amount of information (I) and the amount of data $(V\partial)$.

Consider the application of some provisions of information theory to determine the value of the results of diagnostics of the socio-economic system.

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As a measure of the amount of information we first use a syntactic measure of information. Other measures of measuring the information, as will be shown below, will find their application in assessing the diagnostic value of signs.

Suppose there is some system of predicted states of the socio-economic system that includes *n*states.Using the data of the results of information processing, we determine the statistical probability of occurrence of this condition D_i. We denote this a priori probability $P(D_i)$.

Uncertainty of the system of possible diagnostic results *D* (the diagnosis) is estimated by the value of entropy:

$$H(D) = -\sum P(D_i) \times \log_2 P(D_i), \quad (2)$$

where $H(D)$ *– entropy of the system of diagnoses;*
$P(D_i)$ *– a priory probability of diagnosis* D_i*;*
$\log_2 P(D_i)$ *– logarithm based on 2 values* $P(D_i)$.

The sign "minus $\log_2 P(D_i)$"in the formula is due to the fact that the value $P(D_i) < 1$ and, in accordance, $\log_2 P(D_i) < 0$, and entropy is always a positive quantity.

Systems have the maximum entropy unite equally probable diagnoses.

The entropy of such a system, consisting of *n* equally probable states, can be found by the formula:

$$H(D) = -\sum P(D_i) \times \log_2 P(D_i) = \\ = -\sum \frac{1}{n} \times \log_2 \frac{1}{n} = \log_2 n \quad . \quad (3)$$

For example, in case of equally probable diagnoses of character of crisis and according to the typology of crises resulted earlier we define $n = 20$. The magnitude of the entropy of such a socio-economic system is equal to:

$$H(D) = \log_2 n = \log_2 20 = 4,34 \; . \quad (4)$$

The magnitude of the entropy of the diagnosis system decreases during the study of socio-economic systems, because the study provides an additional information.

Reducing the uncertainty of the system will occur depending on the amount of information that will be received after the diagnostic test.

Thus, the elimination of uncertainty leads to increased efficiency of management action.

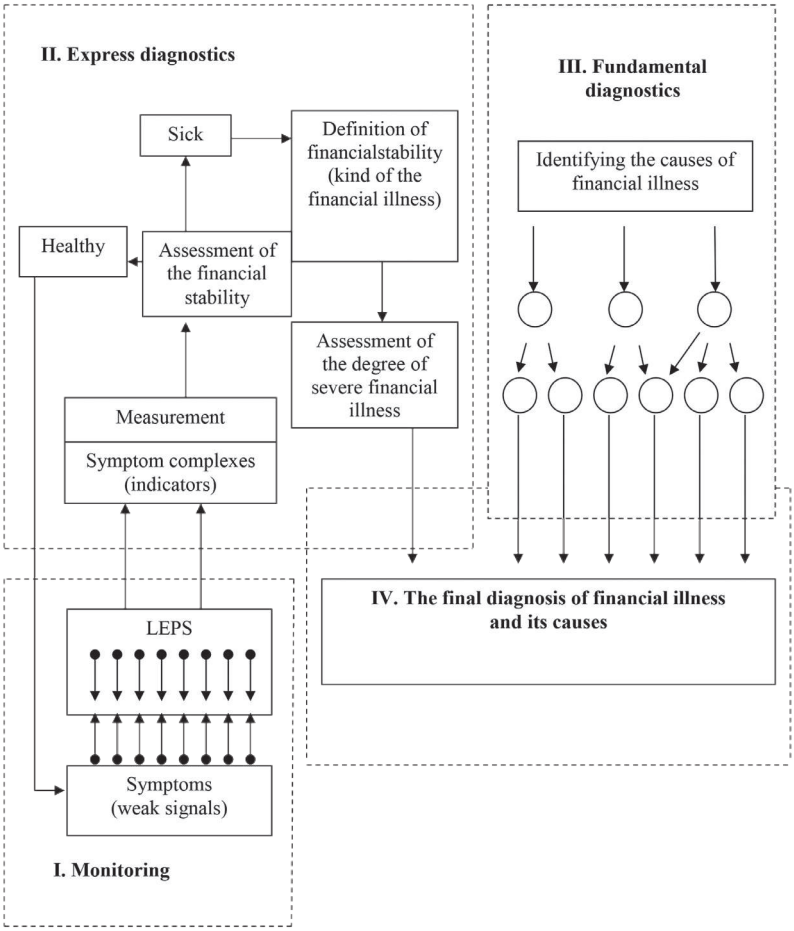

Fig. 1. Diagnostics of stability of functioning of large-scale economic and production systems at the national level

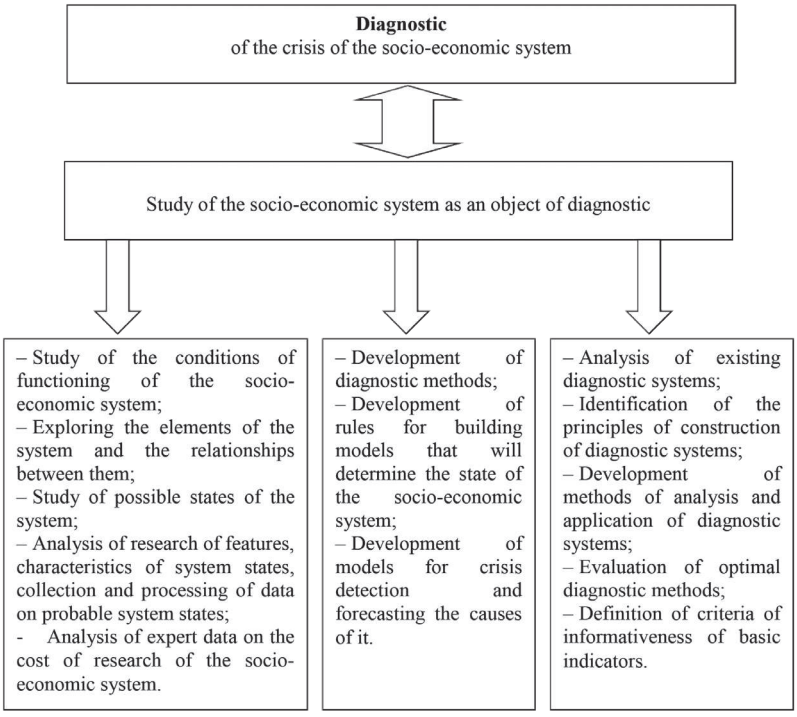

Fig. 2. The subject of diagnostic research in anticrisis management

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As you know, the amount of entered informationcan be measured. It is equal to the difference in entropy of the system before and after the study:

$$Z_{D_i}(k_i) = H(D_i) - H\left(\frac{D_i}{k_i}\right), \quad (5)$$

where $Z_{D_i}(k_i)$ *– the amount of information entered into the system of diagnoses* D *by examination of industrial socio-economic systems on the basis of* k_i *(type of crisis, cause of crisis);*
$H(D_i)$ *– uncertainty of the system of diagnoses before the study (primary entropy);*
$H(D_i/k_i)$ *– uncertainty of the system of diagnoses after the study on the sign* k_i *.*

The amount of entered information $Z_{D_i}(k_i)$ we will consider asthe diagnostic value of a concrete sign k_i in relation to the system of diagnoses D_i, and the unit of measurement of the diagnostic value of the study of socio-economic systems will be the amount of information that eliminates uncertainty in equally probable diagnoses.

Diagnostic weight of the presence of a simple sign k_i at diagnosis D_i determined by the formula:

$$\sigma = \log_2 \frac{P\left(\frac{k_i}{D_i}\right)}{P(k_i)}, \quad (6)$$

where $P(k_i/D_i)$ *– probability (frequency) of the sign* k_i *at diagnosis* D_i *;*
$P(k_i)$ *– probability (frequency) of the sign* k_i *among all this group of diagnoses.*

At the same value $P(k_i/D_i)$ і $P(k_i)$ the diagnostic weight of the sign is zero, ie the ratio $P(k_i/D_i)/P(k_i) = 1$, a $\log_2 1 = 0$.

In other words, with the same value of the probability of the sign k_i among all this group of diagnoses, this feature has no diagnostic value.

The absence of a simple sign also has a diagnostic weight, it is determined in a similar way, but in the formula the value $P(k_i/D_i)$, $P(k_i)$ are replaced accordingly by $(1 - P(k_i/D_i))$ та $(1 - P(k_i))$.

The diagnostic weight of the presence or absence of a simple symptom can be both positive and negative, ie either reduce or increase the probability of a diagnosis.

The results of a study with little diagnostic value for a the diagnosis D_i, can have significant value for another.

It is possible to estimate the overall diagnostic value of the study on the basis of k_i for the entire system of diagnoses D, determined by the amount of information entered by the examination into the system of diagnoses D.

The diagnostic weight of a simple symptom for the whole group of diagnoses will be equal to:

$$Z_D(k_i) = \sum P(D_i) \times Z_{D_i}(k_i). \quad (7)$$

Using this ratio, you can determine the optimal choice of the number of digits of the sign.

With increasing number of discharges, the diagnostic value of the sign increases. At the same time, the sample size will increase. As a result of diagnostics the following volume of information should be received:

$$Z_D(k_i) = \varsigma\, H_0(D), \quad (8)$$

where $0 < \varsigma < 1$ *– the coefficient of completeness of the study;*
$H_0(D)$ *– primary entropy of the system of diagnoses of socio-economic systems.*

For real diagnostic processes the value V should be close to one.

Thus, the amount of information is practically given, and it remains to build the optimal diagnostic process for its accumulation.

When calculating the diagnostic values of the signs, taking into account this dependence, the structure of the formulas remains.

However, they include the conditions of the probability of signs, ie the value of each probability includes the condition of the presence or absence of a certain sign.

For example, the diagnostic weight of the presence of the *r*-th interval of the sign k_2 for diagnosis D_i provided that the s-th interval of the sign k_1 is equal to:

$$Z_{Di}\left(\frac{k_{2s}}{k_{1s}}\right) = \log_2 \frac{P\left(\frac{k_{2s}}{D_s \times k_{1s}}\right)}{P\left(\frac{k_{2s}}{k_{1s}}\right)}. \quad (9)$$

Accordingly, the diagnostic value of the study on the basis of k_2 provided there is a discharge s of the sign k_1, taking into account all possible results of research on a sign k_2, is equal to:

$$Z_{Di}\left(\frac{k_2}{k_{1s}}\right) = \sum P\left(\frac{k_{2s}}{D_s \times k_{1s}}\right) \times \log_2 \frac{P\left(\frac{k_{2s}}{D_s \times k_{1s}}\right)}{P\left(\frac{k_{2s}}{k_{1s}}\right)}, \quad (10)$$

where $Z_{Di}(k_2/k_{1s})$ *– quantitative expression (in bits) of the conditional diagnostic value of the study on the basis of* k_2 *.*

When conducting a study of socio-economic systems, it is necessary to correlate the diagnostic value of the study and the complexity of the study on the basis of k_1.

As a criterion for comparing different diagnostic techniques, we use the concept of the coefficient of optimality of the study– l on the basis of k_1 for the entire system of diagnoses, equal to the value:

$$\lambda = \frac{Z(k_1)}{C_j}. \quad (11)$$

It is extremely difficult to give specific recommendations on the appropriate choice C_j and in the first approximation we will accept the coefficient C_j the same for all surveys. Obviously, the diagnostic examination on the sign k_1 will be more effective than on other grounds if its coefficient of optimality is the highest.

This is the condition for optimal diagnostic research. If you conduct a set of surveys before, consisting of *n* surveys, the total optimality factor is equal to:

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$$\lambda = \frac{Z_D(K)}{\sum C_j}, \qquad (12)$$

where $Z_D(K)$ – diagnostic value of the set of examinations, equal to the information entered by the set of examinations;

- *C_j – the sum of the coefficients of complexity of the study (costs).*

Obviously, the optimality factor will be greatest if the amount of information $Z_D(K)$ is obtained with a smaller number of surveys.

Identification and study of specific properties of economic diagnostics allows to formulate the following conclusions:

– objective development of socio-economic systems means the emergence of newqualities of the object of management;

– the development process leads to a change in the subject of management;

– high entropy of the market macroenvironment of enterprises significantly reduces controllability, reduces the degree of information control over changes in the situation and the probability of forecasting;

– the constant threat of crisis causes the allocation and strengthening of prognostic, anti-crisis, preventive diagnostic functions for the stabilization of economic development of the socio-economic system.

The results of research also show that a sharp increase in the level of complexity of functioning socio-economic systems is significantly reflected in the requirements for quality and efficiency of their management, which objectively requires a conceptual rethinking of the main directions and tasks of diagnosis in management; diagnostic structures in the management process; areas, spheres and directions of diagnostics in time and space; factors of optimization of diagnostic process.

In our opinion, expert financial diagnostics and bankruptcy diagnostics are one of the promising areas in economic diagnostics, the results of which form the information and analytical basis of the management accounting system.

A well-known generalization of the theory of diagnostics is required to synthesize a variety of approaches to the diagnosis of the financial and economic condition of the system, its organizational structure.

This is especially important in the diagnosis of complex objects, when it is impossible to use the classical theory of control, and you need to rely on adaptive, learning and self-learning systems.

The information needed for diagnosis is varied. It is a set of information about the state of the object of management, its past and present, as well as connections, trends and patterns. In each socio-economic system, its information space functions as a whole and develops together with the organization itself.

Diagnosis requires variation of alternative projects to bring the socio-economic system out of the crisis or prevent it. Naturally, this requires information that objectively reflects the real processes in the system.

The structure of economic diagnostics is formed as a stable connection between the conditions of diagnosis and its verified result.

Thus, it has a logical form of truth, expressed in the feasibility of material implication: if timely (A), reliable and with sufficient completeness of information (B), diagnostic procedures are performed by a reasonable method of its processing (C), it is highly likely to obtain reliable knowledge about the object under study, determining the diagnosis (D).

Thus, if A, B, C are observed, then D is true. Conversely, doubts about the reliability of the diagnostic result D are criticized and leads to the verification of the initial conditions: A, B, C. If not true D, then any premise A, B, C is incorrect.

The level of the ratio of costs for the collection, archiving, processing, transmission of information using information and communication technologies in diagnostics and diagnostic efficiency can be demonstrated by the graph shown in Fig. 3.

Thus, in the conditions of further transformation of the domestic economy and intensification of the development of market relations, the issue of development and implementation of the mechanism of sustainable development of the national economy on the basis of innovation becomes a priority.

Stabilization of modern LEPSNL is largely achieved through the formation in enterprises, industries, regions

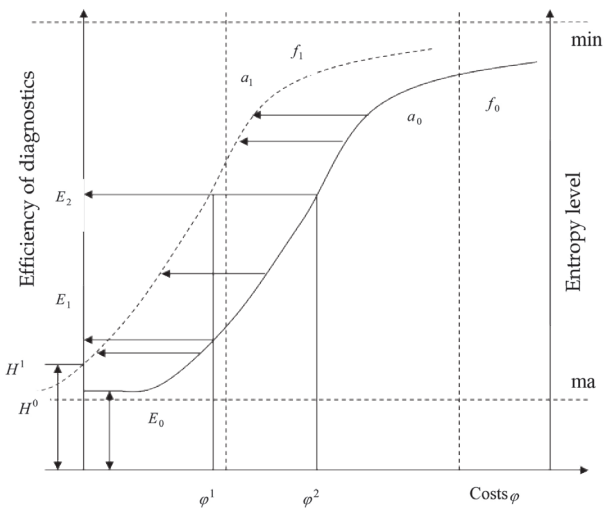

Fig. 3. Graphic interpretation of improving the efficiency of development of the socio-economic system

where f_0 – diagnostic efficiency curve using traditional methods;

f_1 – curve of efficiency of diagnostics with use of elements of information technologies at a stage of preventive remediation;

H^1 – the initial level of information in the case of the use of information and communication technologies at the stage of preventive rehabilitation;

H^0 – initial level of information according to traditional methods;

E_0 – the initial level of efficiency of management decisions;

E_1 – the level of effectiveness of management decisions at the stage of diagnosis using traditional methods;

E_2 – the level of efficiency of managerial decision-making at the stage of diagnostics with the use of information and communication technologies.

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innovation potential and an effective management system for its development, which would allow in destabilization processes in the economy to adapt management methods using a systematic approach to their adaptation to the national economy.

Conclusion

This information makes it possible to identify the essential components of a systems approach to develop methodological foundations for the study of sustainable development of large-scale (national level) socio-economic systems, and above all, their innovative component as a basis for long-term development.

Studies of the specific properties of economic diagnostics of the national economy on an innovative basis, allowed to form the following conclusions and scientific generalizations:

− objective development of a large-scale socio-economic system means the emergence of new qualities in the object of management;

− the development process leads to a change in the subject of management;

− high entropy of the market macroenvironment of enterprises significantly reduces manageability, reduces the degree of information control over changes in the situation, the likelihood of effective diagnosis and forecasting;

− the constant threat of crisis conditions determines the allocation and strengthening of prognostic, anti-crisis, preventive diagnostic functions in relation to the stabilization of economic development of LEPSNL.

The results of the study also show that a sharp increase in the level of complexity of large-scale socio-economic systems significantly affects the requirements for quality and efficiency of their management, which objectively requires a conceptual rethinking of the main directions and objectives of diagnosis in management; diagnostic structures in the management process; areas, spheres and directions of diagnostics in time and space; factors of optimization of diagnostic process.

The theory of diagnostic research is one of the theories that describe and study the mechanisms of functioning in the economy and society, that is, further search is needed for such a diagnostic method that would allow to obtain the most objective and reliable results.

Effective diagnostics of innovative principles of development of the national economy in the long run is possible only under the conditions of formation of effective economic and mathematical tools, which should be sought in the further deepening of our research of this problem.

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