ECONOMIC SECURITY OF STATE: DIAGNOSIS, DESIGN AND STABILITY OF SYSTEM

[a]ARKADI SUKHORUKOV, [b]TETIANA YEHOROVA-HUDKOVA, [c]OLHA SUKHORUKOVA, [d]YURIJ NEUSTROEV, [e]NATALY ZGHADOVA, [f]YURIJ RABOTIN

[a,c]National Technical University of Ukraine "Igor Sikorrsky Kyiv Politechnic Institute", 37, Peremohy Prosp., 03056, Kyiv, Ukraine
[b]Odesa I.I. Mechnikov National University, 2, Dvoryanskaya Str., 65082, Odesa, Ukraine
[d-f]Odesa National University of Technology, 112, Kanatnaya Str., 65039, Odesa, Ukraine
email: [a]Aris47@ukr.net, [b]Tatiana1yeg@gmail.com,
[c]sotopol@ukr.net, *[d]yyurij495@gmail.com,*
[e]Nataliz_225@ukr.net, [f]rabotin.yurij1956@gmail.com

Abstract: The article is devoted to the theoretical and methodological foundations and the mechanism of designing a sustainable system of economic security of the state based on the use of the theory of security science, systems, structural harmony of systems, transdisciplinary approach, and principles of natural management. The objective was to substantiate the innovative design algorithm based on the transdisciplinary approach and the theory of self-organization of systems. The methods of institutional, systemic, transactional, statistical, project analysis and modeling were used. The structural and functional composition of the system of economic security of the state as a set of invariants and variations has been developed. The theoretical provisions and algorithm for designing a sustainable system of economic security of the state are presented; the algorithm for diagnosing the state of economic security of the state based on the use of entropy testing of systems is substantiated and proposed. The applied aspect of the use of the developed theoretical provisions is presented in the form of a project of a number of anti-crisis measures at the macroeconomic level.

Keywords: Economic security, Entropy's testing, Nature-like invariants, Self-organization, System.

1 Introduction

The system of economic security of the state is open, complex, non-linear, dissipative, and emergent [35; 39]. Each complex open system, schematically or enlarged, has three basic components: input - circuit of operational closure - output [45; 48]. In the most detailed and obvious nature, the presence of this property can be observed in nonlinear or non-Gaussian systems with the properties of self-organization and self-harmonization. Operational closedness is a system property that affects the behavior of the system as a result of the interaction of the network of circuit processes; the action of these processes in the circuit forms the emergence of superproperties or the effect of emergence, or the synergistic effect [11; 13]. The property of operational closure is the most important and interacts with the properties of self-organization and self-harmonization. Together, these three properties ensure the stability of the system and its viability to changes and various kinds of bifurcations for the period between these bifurcations and changes in the state of the system and its transition to a new level. In crisis periods, there is a need to measure and assess the state of the system, which is practically impossible to do with the help of ordinary indicators [36; 37; 45].

According to K. Shannon, the assessment of the state of the system with self-subordination properties can be determined by calculating the relative information entropy - an integral indicator, the values of which mathematically correspond to the generalized golden sections or fractions of a unit [5; 23]. Generalized golden intersections or special points of multiple relations of entropy and its antipode, redundancy, or measure of organization, measure of uniformity, when entropy is a measure of diversity, beyond equilibrium - the diversity of the limited [7, 16, 32, 33] - act as measure nodes or invariants or attractors of the system.

2 Method

One of the most important properties of a system is integrity. Interrelated integral systems of objects form a supersystem [30; 39]. Common features for integral systems are their proportionality, harmony, determined by measure or proportionality. Ignoring measure (commensurability) as the most important characteristic of systems or integral objects leads to distortions in science and practice, provoking the emergence of disproportions and crisis situations [45].

The loss of the properties of the integrity of the system, which is based on structural commensurability in all aspects of the social and economic life of society, does not allow achieving its systemic quality. The one always consists of two opposites. "If one of the opposites is probability, then the other is improbability; one of them is a measure of chaos, the other is a measure of order; one is a measure of diversity, the other is a measure of uniformity, and so on. When opposites are measurable, they have their own quantitative measures, are equal to A and B, then they satisfy the law of conservation in the process of striving for a single measure: A + B = 3, or in a relative, weighted form: A + B = 1 (the unit interval is an isomorphic image of a real numerical half-line)" [25; 26; 27].

Thus, there are two measures in the dynamic space of a unit interval:

$$\frac{1}{A}\frac{dA}{dt}$$

and

$$\frac{1}{B}\frac{dB}{dt} \qquad (1)$$

According to Lebesgue's theorem [20], if two measures are given in some domain, then they are multiples. This fact is well known from everyday life: kilograms and tons, minutes and hours, dollars and cents, etc. In this case, this means that, depending on which of these measures is taken as the standard (unit of measurement), one of two equations will be possible, or, where the multiplication factor, according to its definition, is a natural number: 1, 2, 3,…. As a result, according to the previous relation, we have one of the equations, or the roots of this equation obtained at natural values of k - they are called generalized golden sections. They are the quantitatively expressed nodes of the measurement line projected on a single interval: 0.5000 ...; 0.6180 ...; 0.6823 ...; 0.7245, 0.825 ... [15, 48, 16, 17].

The roots of the opposite content, i.e., the most distant from them, obtained at half-integer values of the parameter k = 3/2; 5/2; 7/2, ... can, by analogy with such points, be called antinodes of measure: 0.5698 ...; 0.6540 ...; 0.7053 [32].

The first, measure nodes, are attractors for integral indicators of systems, in particular, for relative information entropy as a measure of the state of any structurally complex system. These values are the basic characteristics of non-equilibrium stable, stationary states of complex systems that self-organize and evolve beyond their equilibrium, where this indicator is relative entropy, equal to 1.

The measure of the amount of information contained in an event, as shown by R. Hartley [11], is the logarithm of the probability of this event, which is taken with the opposite sign: - log p. But the logarithm of the improbability of this event can also be a measure: - log (1- p).

From the multiplicity of these measures, log (1- p) = k log p, the equation follows: p k + p - 1 = 0. Its roots: 0.500; 0618 ...; 0.682 ..., when k = 1, 2, 3, ... and are nodes of measure, where *p* are generalized golden sections. If the state of the system for which the value of the integral measure coincides with these nodes, then the increase in chaos is minimal and there is maximum increase in organization, order, structural harmony, and system quality. When the state of the system for which the integral measure takes a value corresponding to the antinodes (which are indicators of such states where the system properties of objects are manifested in the minimum possible forms), there is a maximum increase in dissipation, dynamic chaos.

Entropy becomes an expression of the amount of information related in the distribution of system components [23; 24]. Normalized to a unit, i.e., taken to its maximum value, it takes the following form:

$$\overline{H} = -\frac{1}{\log n}\sum_{i=1}^{n} p_i \log p_i \qquad (2)$$

where n is the number of system components.

As a measure of chaos, structural diversity, the maximum of which is reached at $\overline{H} = 1$ - in the state of equilibrium of the system (that is, when the weights p_i of its structural components are equal), it is additional to the measure of organization, order, uniformity R and satisfies the conservation law together with it: $\overline{H} + R = 1$.

According to the theorem of Prigozhin [26], beyond the equilibrium of the system, entropy is able to reach a minimum of production (increase), and its antipode R - a maximum: $\frac{d}{dt}\left(\frac{1}{\overline{H}}\frac{d\overline{H}}{dt}\right) = 0$ and accordingly $\frac{d}{dt}\left(\frac{1}{R}\frac{dR}{dt}\right) = 0$. According to the condition of multiplicity of relative measures, $\frac{1}{R}\frac{dR}{dt} = k\frac{1}{\overline{H}}\frac{d\overline{H}}{dt}$, $R = \overline{H}^{k}$, which in combination with the conservation law gives a generator of measure nodes $\overline{H}$: $\overline{H}^{k} + \overline{H} - 1 = 0$. This is the same equation as above, but already for the integral Measure, as the average relative to the statistical set of probabilities, which is able to express both the level of intrastructural diversity and the level of intrasystem chaos.

According to Ziegler's principle, beyond the equilibrium of the system, the production of entropy in it is maximized. Attractors and distractors of non-equilibrium states of the system are nodes and anti-nodes - indicators of the states present in any of the systems regardless of their scale and specific real specificity in the process of self-organization or evolution [32; 33], and the transition between such states is quantized and fixed by measure nodes.

The ontological status of the measure and information entropy, the nodal value of which corresponds to the best options for solutions or optimization, ensuring the stability of the system based on the principle of diversity, should be carefully studied on the example of various economic systems, including the system of economic security of the state [45, 46, 27; 29].

The principle of diversity entered science through the concept of information. In 1948, Shannon and Weaver developed an information-theoretic basis for assessing system diversity; the concept of "information", if used in a broad sense, successfully replaces such expressions as "amount of diversity" or "specificity" [31].

Regarding the stability of complex systems, for example, the system of economic security of the state, it should be noted that this refers to non-equilibrium stability [34; 38]. This is inherent in all systems in which some exchange processes take place on a permanent basis (in stationary mode), as a result of which its structural and functional renewal takes place. In stationary conditions, the system reaches a minimum increase in entropy, and it has a maximum increase in the measure of organization - redundancy. "Passing through a series of intermediate phase states in motion to acquire the best harmonic stationary state of all possible, the system chooses, in the end, a structure - an attractor from some class (innumerable) of this kind of virtual structures with a nodal value of the integral measure fixed for each of them (the same entropy as a measure of limited diversity). Thereby it finds its proper level of intensity of exchange processes, the tension of its characteristic functional mode, and, therefore, - the proper type of system quality" [33].

3 Results

Evidently, it is important to take into account in a timely manner the process of objective attraction to the structure of the attractor of financial funds, distributed among various items of budget expenditures, and to adjust the related structural and financial policy of the state accordingly. Consider Table 1.

Table 1: Expenditure structure according to the State Budget of the USSR (billion rubles in comparable prices)

Articles of expenditure	…	Period A 1964	Period B 1965 1966 1967 1968 1969	…	Period C 1983 1984 1985 1986 1987
Economics	…	45.0	45.2 44.8 44.4 46.6 46.1	…	59.7 60.1 60.4 60.5 60.2
Social and cultural activities	…	38.2	39.9 40.4 40.6 38.8 39.1	…	34.4 34.2 33.6 33.8 34.2
Defense	…	15.5	13.7 13.4 13.7 13.3 13.5	…	5.1 4.9 5.2 4.9 4.9
Management	…	1.3	1.2 1.4 1.3 1.3 1.3	…	0.8 0.8 0.8 0.8 0.7
Value $\hat{H}$	…	0.774	0.758 0.761 0.761 0.756 0.758	…	0.624 0.620 0.623 0.618 0.617
Node of the measure $\hat{H}$		0.778 ($k=6$)	0.755 ($k=5$)		0.618 ($k=2$)

Source: [33]

From Table 1, it is evident how, passing through intermediate phase states, from period A to period B, which are characterized by certain nodal values of the integral measure, the economic system "Budget of the USSR" in its spending part in the process of evolution objectively seeks to find such a distribution of components for which this measure is equal to the nodal value of 0.618. It is the most natural, as it satisfies the Euclidean metric. Let us note that the specific weight of the structural dominant of the distribution - "Expenditure on the national economy" - also approaches the same nodal value. In natural systems, self-organization of complex systems takes place in the form of self-harmonization, for example, the system of phyllotaxis, as statistically and spatially distributed, where nodes of measure, generalized golden sections visually reveal the properties of an attractor (for example, a sunflower flower).

To illustrate the structural dynamics of society, in which the golden ratio naturally and objectively reveals its attractive properties, consider an example from the economic situation of the USA (Table 2).

Table 2: Structural transformations of the US economy and the evolution of its integral characteristic - relative entropy

Year	Number of employed, %				Informational entropy $\hat{H}$ as
	Agriculture	Material production*	Service area**	Unemployed	Integral measure: real
The period of the Great Depression					
1929	21.1	38.7	37.1	3.1	0.845
1931	20.3	31.0	32.9	15.8	0.967
1933	19.5	26.9	28.9	24.7	0.993 (max)
1934	18.9	29.2	30.3	21.6	0.986
1940	17.0	33.5	35.0	14.5	0.949
The period of the 2nd World War and the post-war years					
1942	15.3	37.8	42.5	4.4	0.834
1943	14.1	35.8	48.4	1.7	0.769
1944	13.6	34.1	51.3	1.0	0.741
1948	12.3	39.6	44.4	3.7	0.799 (0.797)
1951	10.5	39.5	46.8	3.2	0.771 (0.778)
1954	9.4	37.5	47.7	5.4	0.794(0.797)
1955	9.6	38.2	47.9	4.3	0.779 (0.778)
1958	8.0	36.9	48.5	6.6	0.794 (0.796)
The period of the beginning of economic growth					
1962	6.8	36.7	51.1	5.4	0.758 (0,755)
1965	5.7	36.4	53.5	4.4	0.724 (0.725)
1968	4.7	34.4	57.4	3.5	0.683 (0.682)
1973	3,8	32,6	58,8	4,8	0,684 (0.682)
1978	3.3	30.3	60.4	6.0	0,684 (0.682)
1980	3.1	28.7	61.2	7.0	0.687 (0.682)
1984	2.9	27.6	62.1	7.4	0.683 (0.682)
Period of stabilization of economic growth					
1988	2.6	25.5	66.5	5.4	0.629 (0.618)
1989	2.5	24.8	67.5	5.2	0.618 (0.618)
1994	2.6	22.5	68.9	6.0	0.617 (0.618)
* Includes: industry, mining, construction, etc. ** Includes: service industry, finance, insurance, home ownership, trade, transportation, public housing, state and federal services, military.					

Modified by the authors according to sources: [2;33]

From the given data, it follows that during the Great Depression, the indicator $\hat{H}$ - the relative entropy of a given distribution of structural groups of living labor - was closest to unity, since the structure was characterized by the maximum proximity to the equality of the weights of its components, which corresponded to the minimum of functional, production potential, and, therefore, also the maximum chaos that engulfed society.

In order to overcome this situation as soon as possible and revive its industrial atmosphere, the USA was very interested in participating in the Second World War: bled by the Great Depression, the economy was still in a state of crisis in the early 1940s, for more than a decade of War years (1941-1944) - although the economy is progressing, but with jumps "back and forth" at a rather low economic potential and the level of exchange in society as a social organism. It is still deeply disharmonized: the relative entropy, as an integral characteristic of its structure, gravitates towards the antinodes of the measure, which are far from the optimum - from the invariant of 0.618.

In the post-war years (1948-1958), the economy is in a state of "cold war", structurally and functionally it is still not sustainable. It alternately has fluctuations of growth and loss of quality. The next decade, from the beginning of the 1960s, is characterized by progress in growth. From 1968 to 1984, there was staying in a stable state, which is characterized by a pre-optimal node of measure - 0.682. Finally, since 1988, there was the acquisition of an evolutionarily mature state of harmony with maximum opportunities for revealing one's own potential and the flow of exchange processes in an effective functional mode.

Calculations confirm the value of the integral indicator, information entropy $\hat{H}$, as a node of measure.

Speaking about the stability of complex systems, for example, the system of economic security of the state, it should be noted that the stability meant here is unbalanced.
It is clear that the process of objective attraction to the structure of the attractor of financial funds, distributed among various items of budget expenditures, is important to control and correct in a timely manner, affecting the related economic, structural, financial, etc. state policy. Also, such an integral indicator can be used in the diagnosis of processes related to the management of business structures, even TNCs [49]. This clearly confirms the value of the integral indicator, information entropy $\hat{H}$, as a node of measure or attractor.

4 Discussion

Self-organization of the system of economic security of the state is provided by a set of mathematical constants of a stable system, namely constants inherent in any natural system [12; 28; 44]. The hypothesis regarding the possibility of designing a stable system is based on primary design, or on bringing into an artificial system for the purpose of its redesign as a set of mathematical constants of living nature [45-48].

A comprehensive study of the phenomenon of self-organization of the economic security system is an actual direction of modern theoretical research and has significant applied value. The economic basis for analyzing economic security as a self-organized system is transaction costs [7]. Namely the comparison of the price of legality and illegality of using the market mechanism initiates the possibility of improving the management system.

An indicator of the presence of problems in the system of managing the economic system in general and the system of economic security of the state is the shadow economy and its level. Business chooses between the price of legality and illegality and this also belongs to the display of integrity. "The main features of the system, which determine its identity and integrity, and are not inherent to any of its components, are not deduced from the properties of the parts, but arise from their combination. This effect is called emergent" [31; 45].

Prof. Khitsenko defines self-organization as "Involuntary process of growth and maintenance of mutual coordination of system elements by increasing its complexity and imbalance" [13].

Prigozhin, one of the founders of the theory of self-organization, connected this phenomenon with the concept of dissipative structure - a structure that spontaneously arises in open unbalanced systems. Naeely the "combined actions" or coherent behavior of the elements of dissipative structures is the phenomenon that characterizes the processes of self-organization". Prigozhin defines self-organization as "the choice of one of the solutions arising at the point of bifurcation, which is determined by the laws of probability" [24]. Practically this is how other scientists described this phenomenon [35; 39].

The phenomenon of self-organization is related to such a concept as chaos or dynamic chaos [33]. Prigozhin and Stengers claim that "Events are a consequence of the instability of chaos" [23]; "Chaos" and "Matter" are closely related concepts, since dynamic chaos is at the basis of all sciences" [24; 25]. In the work of Prigozhin and Stengers, the provision about two different types of manifestation of a chaotic state is given, and namely at the micro-levels of "formalizing dynamic chaos" and at the macro-levels of "dissipative constructive chaos" the conclusion regarding the problems of reversibility and irreversibility is substantiated [24;25].

In turn, the problem of irreversibility is related to evolutionary processes "Under evolutionary or irreversible processes, we understand those changes that, in the absence of sharp external perturbation influences, proceed in a certain direction and in the same direction" [33]; "However, the national economic process as a whole is characterized by ... an irreversible process of transition from one degree or stage to another" [2; 33].

The constant of the golden ratio and its mathematical derivatives are structural invariants, attractors that should be focused on when designing artificial supersystems and their components [12, 28, 43, 49]. The stages of the design methodology are as follows:

1. Assessment of the status of the system (for example, the system of economic security of the state).
2. Evaluation of the time interval between the occurrence and satisfaction of the need (in a specific system).
3. Assessment of the structural and functional state of the system.
4. Assessment of the level of vertical integration of business across industries and sectors of the economy and the share of added value in the gross domestic product.
5. Comparison of evaluation results with attractors representing a recurrent series of golden sections: 0.500 ...; 0.618 ...; 0.682 ...; 0.725… 0.825….
6. Control of reliability and viability of the system (estimation of deviations).
7. System entropy testing (relative information entropy calculation).
8. Formulation of the system restructuring (reengineering) project.
9. Implementation of the project and assessment of compliance of the designed system for structural and functional compliance with the constant of the golden ratio and its derivatives [45; 49].

The economic cenosis model corresponding to the biological cenosis model was developed by V.V. Fufaev [8]. Its essence consists in the analysis of regularities for various business forms:

1. A list of all types of activities is drawn up based on a sample of organizations of a separate economic cenosis.
2. According to the list, drawing up a listing of organizations with the same main type of activity is carried out.
3. Activities represented in this sample by the same number of organizations are grouped into castes.
4. Castes are placed in order of decreasing number of types of activities in them, as a result of which the distribution of types of activities is obtained according to repetition.

To diagnose the state of economic cenoses (as well as other types of formations) on the subject of "norm-pathology", the H-distribution by B.I. Kudrin [18; 19] is applied. In addition, in our opinion, the diagnosis of "norm – pathology" can be performed using a recurrent series of golden sections - where the nodes of the measure characterize the norm, and the antinodes define pathology.

In continuation of replenishment of the set of tools of nature-like management methodology [12, 28, 40], it is necessary to present the discovery of V.P. Burdakov and V.T. Volov, according to which, in any complex-organized system, as in an organism, regardless of its subject specifics - technical-technological, biological or social - the internal load of the processes of resource life support is self-similarity, has a fractal nature based on the invariant of the golden section [3, 21, 22, 46].

The authors singled out a fundamental set of indicators of the functioning of a complex system, which, thanks to exchange processes, is a stable and cyclical organism that actually renews itself. These indicators are combined in the form of five clusters and subclusters:

1. Energetic (38%)
1.1. Energy resources of the body (14.44%)
1.2. Energy supply of transport (10.26%)
E 1.3. Energy protection (safety) of the body (6.08%)
1.4. Energy supply of production functions (4.94%)
1.5. Power supply of informatics (2.28%)
2. Transport (27%)
2.1. Transport resources of the body (7.29%)
2.2. Transport provision of energy sector (10.26%)
T 2.3. Transport provision of security (4.32%)
2.4. Transport support of production (3.51%)
2.5. Transport support of informatics (1.62%)
3. Protective (16%)
3.1. Resources for ensuring the safety of the body (2.56%)
3.2. Transport safety (4.32%)
B 3.3. Security of body energy (6.08%)
3.4. Production safety (2.08%)
3.5. IT security (0.96%)
4. Production (13%)
4.1. Production resources of the body (1.69%)
4.2. Production maintenance of transport (3.51%)
P 4.3. Production (technological) ensuring of protection (2.08%)
4.4. Production support (maintenance) of the energy industry (4.94%)
4.5. Production support of informatics (0.78%)
5. Informational (6%)
5.1. Information resources of the body (0.36%)
5.2. Transport information support (1.62%)
I 5.3. Information provision of security (0.96%)
5.4. Information provision of production (0.78%)
5.5. Information provision (maintenance) of the energy industry (2.28%)

These clusters characterize the distribution of resources in complex systems as organisms (including biological, technical-technological, and social systems) according to the following fundamental categories or positions: Energy (E) - Transport (T) - Security (B) - Production (P) - Information (I) [2].

For example, for a social organism, the structure of energy resource costs (E) in percentage terms looks as follows: Information provision of energy (2.28%) + Production service of energy (4.94%) + Ensuring security of energy (6.08%) + Transport energy maintenance (10.26%) + Energy resources, i.e., water, light, heat, food, fodder, electricity, oxygen, motor fuel, fuel for thermal power plants, nuclear power plants, etc. (14.44%) + Energy supply of transport and exchanges (10.26%) + Energy supply of security (6.08%) + Energy supply of production (4.94%) + Energy supply of informatics (2.28%) = 61.56 (%).

As a result, the entire set of indicators of the necessary (functional) resource or the "Matrix of fractal-cluster relations of the social organism" [3], is given by the following weight values for the selected factors of life support (%): E = 61.56; T = 26.19; B = 8.64; P = 3.24; I = 0.37. The relative information entropy calculated from these specific gravity quantities is: H = –(0.2987 + 0.3509 + 0.2116 + 0.1111 + 0.0207) / log5 = 0.617.

Also, when designing stable systems, namely, the system of economic security of the state, the mathematical law of elementary synthesis proposed by V. Vladimirov should also be taken into account.

The golden ratio corresponds to the maximum entropy (degree of chaos), occupying the place of the arithmetic mean (d = 0.5h) of two extreme, ordered processes: bisection (d = 0) and reduction (d = h).

The evolution and self-organization of viable systems is characterized by increasing the number in unequal portions with ratios proportional to the golden constant. Natural and human-induced processes of cumulative accumulation and systemic transformations are viable only if they correspond to the harmonious golden ratio, a special case of which is the classical golden ratio.

Vladimirov [43] expanded the very concept of the golden ratio: "if the difference d=b–a is equal to half of the harmonic mean h, or if b/a=F, then Whole, More, and Less are necessarily connected by the golden ratio. The recurrent ratio of the golden section is not only $f_n+2=f_n+1+f_n$ (h=2), but also any other equation of the type $f_n+2=(0.5h)f_n+1+(0.5h)^2f_n$. For example, $f_n+2=2f_n+1+4f_n$; $f_n+2=1.5f_n+1+2.25f_n$; $f_n+2=10f_n+1+100f_n$ is also the equation of the golden section, but for other values (4; 3; 20) of the harmonic mean h".

Vladimirov proposed the law of elementary synthesis: "a system synthesized according to the law of recursion has maximum entropy and dynamic stability in the case when it has a differential equation of the harmonic golden ratio as a mathematical model. Only a special case of this mathematical model is widely known - the Fibonacci equation" [43].

5 Conclusion

The stability of any system, in that case the system of economic security of the state, its ability to self-organize and self-harmonize in conditions of change, as well as the arising of emergent properties in the contour of the operational closedness of the system is determined by its structural proportions. The structural harmony of the system and its superproperties depends on the balance of invariants and variations in its structure. The invariants of the system, or attractors, are the mathematical constants that form the above-mentioned properties. The universal mathematical constant of any system with the properties of self-organization and self-harmonization is the Phidias number, or the constant of the golden ratio. The more proportions of the golden ratio and its derivatives the system contains, the more viable it is. At the same time, the level of system redundancy is also optimized.

The assessment of the state of a system with the properties of self-subordination according to K. Shannon can be determined by calculating the relative information entropy - an integral indicator, the values of which mathematically correspond to the generalized golden sections or fractions of a unit.

Nodes measure the recurrent series of golden sections, - namely 0.5000 ...; 0.6180 ...; 0.6823 ...; 0.7245, 0825 ... , are attractors for integral indicators of systems, in particular, for relative information entropy as measures of the state of any structurally complex system. These values are the basic characteristics of non-equilibrium stable, stationary states, self-organizing and evolving complex systems beyond the equilibrium of the latter, where this indicator, the relative entropy, is equal to 1.

Entropy becomes an expression of the amount of information related in the distribution of system components. Normalized to unity, that is, taken to its maximum value,

$$\overline{H} = -\frac{1}{\log n}\sum_{i=1}^{n} p_i \log p_i \tag{3}$$

where *n* is the number of system components

Being a measure of chaos, structural diversity, the maximum of which is reached at $\overline{H}$ = 1 - in the state of equilibrium of the system (that is, when the weights pi of its structural components are equal), it is additional to the measure of organization, order, uniformity R and together with it satisfies the law of conservation: $\overline{H}$ + R = 1.

The hypothesis regarding the possibility of designing a stable system is based on the primary design, or on bringing into the artificial system for the purpose of re-designing the set of mathematical constants of living nature.

A comprehensive study of the phenomenon of self-organization of economic security is an actual direction of modern theoretical research and has significant applied significance.

The economic basis for analyzing economic security as a self-organized system is transaction costs [7]. Namely the comparison of the price of legality and illegality of using the market mechanism initiates the possibility of improving the management system. An indicator of the presence of problems in the system of managing the economic system in general and the system of economic security of the state is the shadow economy and its level. Business chooses between the price of legality and illegality and this also belongs to the display of integrity.

The constant of the golden section and its mathematical derivatives refer to structural invariants, attractors that should be focused on when designing artificial supersystems and their components.

The stages of the diagnosis and design methodologies are as follows:

1. Assessment of the status of the system (for example - the system of economic security of the state).
2. Evaluation of the time interval between the occurrence and satisfaction of the need (in a specific system).
3. Assessment of the structural and functional state of the system.
4. Assessment of the level of vertical integration of business in terms of industries and sectors of the economy and the share of added value in GDP; using a coenological approach.
5. Comparison of evaluation results with attractors representing a recurrent series of golden sections: 0.500 ...; 0.618 ...; 0.682 ...; 0.725, ..0.825.
6. Control of reliability and viability of the system (estimation of deviations).
7. System testing: entropy (relative information entropy calculation), for compliance with fractal-cluster constants and the law of elementary synthesis.
8. Formulation of the system restructuring (reengineering) project.
9. Implementation of the project and assessment of compliance of the designed system for structural and functional compliance with the constant of the golden ratio and its derivatives.

The methodology formulated by the authors is innovative in terms of tools of analysis and synthesis. Its implementation in the practice of management and practical use (for example, in crisis conditions) will contribute not only to the diagnosis of the state of the economic security system of the state and its components, but also to the development of various target contours according to the principle of "security-danger" in relation to the components of the system. Also, the implementation of the methodology can initiate the direction of conducting research on how to design a sustainable system of economic security of the state - as a component of a hierarchical system of economic security, or as a network of economic security. A logical and structural approach to project management should be a working tool when developing such a project.

Literature:

1. Barantsev, R.G. (2003). *Synergetics in modern natural science.* Moscpow: Editorial URSS, 2003 (Series "Synergetics: from the past to the future").
2. Boulding, K.E. (1994). *The Structure of a Modern Economy: The United States, 1929 - 1989*. N. Y.: Macmillan.
3. Burdakov, V.P., & Volov V.T. (2012). Fractal-cluster similarity of organisms and the "golden section". "Academy of Trinitarianism", 77, pp. 6567.
4. Burlachenko E.V. *What do metallic proportions say?* http://314159.ru/burlachenko/burlachenko1.htm
5. Chernavsky, D.S. (2004). Synergy and information. Dynamic theory of information. / Edition 2nd corrected and supplemented. Moscow: Editorial URSS, (Series "Synergy: from the past to the future").
6. Chernyaev, A.F. (1998). *Gold of Kyivan Rus. The Russian matrix is the basis of the golden ratio*. Moscow: White Alva, 1998.
7. Coase, R.G. (1995). *The nature of the firm. In the book: Theory of the firm*. St. Petersburg: School of Economics.

8. Fufaev, V. V. (2006). *Economic cenozys of organizations*. Moscow: Abakan.
9. Ghazale, M. (2002). *Gnomon. From pharaohs to fractals*. Moscow-Izhevsk: Computer Research Institute.
10. Haken, G. (2005). *Information and self-organization. A macroscopic approach to complex systems*. KomKnyga.
11. Hartley, R.V. L. (1959). *Transfer of information*. R.V.L. Hartley. Moscow: Nauka.
12. Kappraff, J. (2002). *Beyond Measure. A Guided Tour Through Nature, Myth, and Number*. Singapore: World Scientific.
13. Khitsenko, V.E. (2001). A few steps to a new system methodology. *Sociological Research, 3*, 12-24.
14. Khitsenko, V.E. (n.d.). *Self-organization: formation of the theory and perspective of social programs*. http://captador.livejournal.com/233506.html
15. Kosinov, N.V. (n.d.). *Golden ratio, golden constants and golden theorems*. http://314159.ru/kosinov/kosinov29.htm
16. Kosinov, N.V. (n.d.) *Golden invariants of harmonic sequences*. http://314159.ru/kosinov/kosinov21.htm
17. Kosinov, N.V. (n.d.). *Harmonic sequences*. http://314159.ru/kosinov/kosinov21.htm
18. Kudrin, B. I. (2002). Mathematics of cenozov: species, rank-species, rank-by-parameter hyperbolic H-distributions and laws of Lotka, Zipf, Pareto, Mandelbrot. *Center for Systemic Studies. Cenological Studies, 19*, 357-412.
19. Kudrin, B. I. (2009). Two discoveries: the phenomenon of invariance of the structure of technocenoses and the law of informational selection. *Cenological Studies. Technics, 44* http://www.kudrinbi.ru/public/10801/index.htm
20. Lebesgue, A. (1960). On the measurement of quantities (2nd Ed.). Uchpedgiz.
21. Mandelbrot, B.B. (1977). *Fractals: Form, Chance and Dimension*. San Francisco: Freeman.
22. Mandelbrot, B.B. (1982). *The Fractal Geometry of Nature*. San Francisco: Freeman.
23. Prangishvili, I. V. (2003). *Entropy and other system regularities: the issue of managing complex systems*. Moscow: Nauka.
24. Prigozhin, I.R. (1989). Rediscovering time. *A Question of Philosophy*, 3. 11.
25. Prigozhin, I., & Stengers, I. (2003). *Time, Chaos, Quantum: Towards a Solution to the Time Paradox*. Moscow: Editorial URSS.
26. Prigozhin, I. (2002). *From the existing to the emerging. Time and complexity in the physical sciences*. Moscow: Editorial URSS.
27. Semenyuta, N.F. (2012). *When making a decision - start with the golden ratio*. Belarusian State University of Transport. Gomel: BelGUT.
28. Shevelyov, I.Sh., Marutaev, M.A., & Shmelyov, I.P. (1990). *The golden intersection. Three views on the nature of harmony*. Moscow. Budizdat.
29. Sidak, V.S. Yehorova-Hudkova, T.I., & Karabanov, A.V. (2013). Possibilities of using the cenological approach in the design of the economic security system of the state. http://ekonomika.by/downloads/National_economy_Minsk_December_13_2013.pdf
30. Sorokin, P. A. (1992). *Sociocultural dynamics. Man. Civilization. Society*. Moscow.
31. Soroko, E.M., Yehorova-Hudkova, T.I., & Tsai Bey. (2018). Formation of the financial model of economic growth: measure, measurement and mathematical constants. V International scientific and practical internet conference, Financial system of the country: Trends and prospects of development, Collection of scientific theses: Ostrog, October 11-12, 2018. Publishing House of the National University "Ostrozh Academy", 2018. Tezy_fin_systema_2018_web.pdf
32. Soroko, E.M. (2019). *Golden intersections, processes of self-organization and evolution of systems: Introduction to the general theory of harmony of systems* (6th ed.). Moscow: Book house LIBROKOM.
33. Soroko, E.M. (2011). Processes of self-organization of systems: do the principles of Prigozhin and Ziegler contradict each other. Great transformers of natural science: Maria Skladovska-Curie: Materials XXIII International. readings Minsk, pp. 86-90.
34. Stakhov, A.P. (n.d.). Metal Proportions - new mathematical constants of Nature. "Academy of Trinitarianism", Moscow, El No. 77-6567, publ. 14748, http://www.trinitas.ru/rus/doc/0232/004a/02321079.htm
35. Sukhorukov, A.I. (2005). *Modern problems of financial security of Ukraine (scientific edition)*. Kyiv: Akadempress.
36. Sukhorukov, A.I. (2015). A synergistic model of the system of ensuring the economic security of the state. In the book: Sustainable development – 21st century: management, technologies, models. Discussions 2015: Publishing house. Chabanenko Yu.A., pp. 84-96.
37. Sukhorukov, A.I., & Sukhorukova, O.A. (2018). Mainstream problems of the international economy and international economic security. Scientific Bulletin of the International Humanitarian University, Series: Economics and Management, 36(32), part 1, pp. 4-9.
38. Sukhorukov, A.I. (2020). The impact of structural changes on the security of economic systems. Sustainable development – 21st century. Discussions 2020, pp. 67-75.
39. The supersystem and the resource. http://tainy-upravleniya-chelovechestvom.ru/supersistemy-i-tajnaavtosinxronizaciya
40. Vera, W. (1998). *From the Golden Mean to Chaos*. Nueva Librerna.
41. Vera, W. (1990). The metallic means family and multifractal spectra. *Nonlinear Analysis, 36*, 721-74533
42. Vitali, S., Glattfelder, J., & Battiston, S. (2010). Thenetwork of global corporate control. Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland.
43. Vladimirov, V.L., & Stakhov, A.P. (2011). Entropy of the golden ratio (another secret of the golden ratio revealed). "Academy of Trinitarianism", M., El No. 77-6567, publ. 16523. http://www.trinitas.ru/rus/doc/0232/009a/02321199.htm
44. Yanok, V.F. (1993). *Philosophy of harmony*. St. Petersburg: Chernyshev Publishing House.
45. Yehorova-Hudkova, T.I. (2022). *The system of economic security of the state in conditions of change: transdisciplinarity, self-organization, nature-like approach*. Odesa: KP Odesa City Typography.
46. Yehorova-Hudkova, T.I. (2018). Nature-like management: models, mathematical constants and possibilities of application in crisis macroeconomic conditions. Law, economy and management: genesis, current state and development prospects: Mater. International science and practice conf., dedicate. On the 20th anniversary of the Economic and Legal Faculty of the I. I. Mechnikov ONU. Odesa, September 14–15. http://dspace.onu.edu.ua:8080/handle/123456789/18714.
47. Yehorova-Hudkova, T.I. (2010). The concept of economic security based on the principles of the mathematics of harmony. *Economic Bulletin of the National Mining University, 1*, 9-15.
48. Yehorova-Hudkova, T.I. (2014). Worldview and methodological aspects of designing sustainable economic systems: The Law of the Golden Section. *Collection of Papers of the North-Eastern National University named after Volodymyr Dahl. Series: Management, 26* (1), 169-184.
49. Yegorova-Gudkov, T. (2012). Projecting of steady complexity economic systems on self-organizing principles as a component of anti-crisis strategy. Abstract of 2012 International Conference on Trends and Cycles in Global Dynamics and Perspectives of World Development October 13–15, 2012, Chengdu, China, pp. 40-41

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