



Tkachuk N.

## EVOLUTIONAL RESEARCH OF THE BANKING SYSTEM ON THE POSITIONS OF COMPATIBILITY, DYNAMICITY AND SELF-ORGANIZATION

Об'єктом дослідження є банківська система як економічна система мікро-рівня, що характеризується такими ознаками, як: складність, динамічність і здатність до самоорганізації. Одним із найбільш проблемних місць є розуміння особливостей поступального розвитку банківської системи з позицій синергетичного підходу, який дозволяє пояснити трансформаційні процеси, що раніше вважалися випадковими, непередбачуваними й не підлягали концептуалізації.

В ході дослідження використовувались методи абстрактно-логічного і системного аналізу при теоретичному обґрунтуванні ознак сучасної банківської системи. А також метод логічних узагальнень при виявленні особливостей характеристик складної економічної системи. Вивчення функціонування сучасної банківської системи повинно базуватися на використанні теорії систем, теорії складних систем і теорії динамічних систем. Доведено, що процеси самоорганізації можуть відбуватися лише в тих економічних системах, які мають високий рівень складності, є динамічними і непередбачуваними в довгостроковому періоді, до складу яких слід зараховувати й банківську систему.

Запропоновано банківську систему розуміти як складну, динамічну економічну систему:

- якій властиві механізми самоорганізації;
- яку можна описати інтеграційними, термодинамічними параметрами, що в повній мірі відображають обмін матеріальних і фінансових ресурсів з оточуючим середовищем;
- яка вирізняється динамічністю та нерівноважністю свого розвитку.

Завдяки цьому забезпечується можливість розуміння закономірностей функціонування банківської системи, що є необхідною передумовою забезпечення її життєздатності та стійкості в умовах впливу різноманітних екзогенних і ендогенних факторів. У порівнянні з відомим системним аналізом, запропоноване використання синергетики уможливіло пояснення поступального розвитку банківської системи в певній мірі флуктуаціями, які важко передбачати, але які є іманентними самій системі. Саме за умов існування таких флуктуацій відбувається спонтанне утворення нових структур у банківській системі, тобто відбувається самоорганізація.

**Ключові слова:** складна та динамічна економічна система, банківська система, теорія систем, синергетичний підхід.

### 1. Introduction

In modern economic conditions, the requirements for the banking system are increasing, which should contribute to sustainable economic growth and increase the competitiveness of the economic complex in the context of gradual integration into the European and global economic space. This is due to the special role of banks as leading financial intermediaries, ensuring the movement of financial resources between individual regions, industries and economic entities in order to meet their needs and requests.

The banking system was formed and develops as a result of the cooperative interaction of all its elements, and its functioning is accompanied by constant influences by both internal and external factors. In the course of development of the banking system there is a gradual accumulation of changes and the generation of new properties. The deployment of processes that are inevitable in time is accompanied by qualitative changes in the banking system: banking institutions, providing their services to clients, at the end of the process, as a result of

accumulating financial and commercial experience, acquire new features.

The use of extrapolation and modeling methods made it possible to foresee certain crisis situations earlier, and also to predict the behavior of the system under the condition of changing its parameters, taking into account the experience of previous periods, that is, there was a clear determinism of the banking system. In modern conditions of market development, it is precisely synergetic that allows to explain processes that were previously considered random, unpredictable and were not subject to conceptualization. The banking system as a complex economic system can be recognized on the basis of the synergetic research methodology, which makes it possible to supplement the general scientific picture of development with ideas about the features of the development and reproduction of open systems using the terminology of synergistic thinking. This is the reason for the relevance of the topic of scientific research, its undeniable necessity and importance in modern conditions of market development.

## 2. The object of research and its technological audit

*The object of research* is the banking system as an economic system of micro-level, which is characterized by complexity, dynamism and ability to self-organization. The banking system as a complex, multicomponent system is constantly in a state of disequilibrium, is not a closed system, the processes of self-organization and cooperation of bonds are clearly expressed in it. In addition, the states of bifurcation are predictable, and the chaos generated by bifurcation of non-equilibrium states, nonlinear systems is a structuring factor for the further development of the system. The use of a synergistic approach is most appropriate in the study of complex, dynamic, nonlinear systems capable of self-organization and characterized by instability and disequilibrium, which should also include the banking system.

So, one of the problem areas is understanding the patterns of functioning and development of the banking system from the standpoint of a synergistic approach. This problem is of little-studied, since the vast majority of scientists use a systematic approach in studying the banking system; this is what gives a large field of activity for further research. At the heart of the synergistic approach to the study of economic systems are such characteristics as: complexity, dynamism, openness, coherence, nonlinearity, necessary for the self-organization of the system. Therefore, let's consider it necessary to more fully disclose the essence of the above-mentioned features in the functioning of the banking system.

## 3. The aim and objectives of research

*The aim of research* is studying such signs of the modern banking system as: complexity, dynamism and self-organization.

To achieve the aim of research the following objectives are defined:

1. To identify the economic content of the concepts: «complexity», «dynamism», «self-organization» as signs of the banking system for a synergistic approach.
2. To determine the prerequisites and features of self-organizing processes in the banking system.

## 4. Research of existing solutions of the problem

The research of theoretical and methodological aspects of the functioning of economic systems is devoted to the work of many scientists. These papers describe the features of complex systems according to the general theory of systems [1–3]. The essence of complex systems according to the theory of complex systems is disclosed in [4]. Certain aspects of the theory of dynamic systems are disclosed in [5, 6]. In [7], the principles of differentiation and communication are considered in the context of managing an economic system. The concept of complexity of systems is associated with their lack of organization [8], as well as with the dynamism of its development [9]. The emergence of as properties of complex systems is the work [10]. The concept of complexity is organically intertwined with the specifics of dissipative systems based on the principles of irreversibility of development of processes, probability and

instability [11]. The main principles of the functioning of dynamic systems are considered in [12]. In works [13, 14], the nature of self-organization of complex economic systems from the standpoint of a synergistic approach is adequately covered. The emphasis on the three types of self-organization of complex economic systems was made in [15]. The ability to self-organize complex systems according to the synergistic approach is emphasized in [16, 17].

So, the essence of complexity, dynamism and self-organization of complex economic systems and their transposed into the banking system, which should be considered one of the varieties of the economic system at the micro level, has been investigated. But many more applied issues related to openness and the ability to self-organize the banking system in modern conditions of market development require a constructive outcome. Today, issues of transformation and consolidation in the banking system are important, due to the nonlinear nature of the interaction of the elements of the system (banks). This is what leads to the emergence of new structures, new properties of the system and the creation of a synergistic effect.

## 5. Methods of research

General scientific and special research methods are applied during the execution of the work:

- methods of abstract logical and system analysis in the theoretical justification of the characteristics of the modern banking system;
- methods of analytical and logical generalizations in detecting the evolutionary characteristics of the characteristics of a complex economic system;
- methods of analysis and synthesis for detail in the study of the essence of complexity, dynamism and ability to self-organize the banking system with the wording of the relevant conclusions;
- methods of analogy and comparison in the study of the features of the functioning of complex economic systems from the standpoint of synergetics.

## 6. Research results

Modern economics has entered a new phase of its development, due to:

- firstly, the increasing complexity and globalization of the world economy and banking;
- secondly, the invasion of economics of mathematical methods of nonlinear dynamics;
- thirdly, the emergence of new computer technologies made possible the study of complex phenomena in the economy and the banking sector.

Therefore, the problems of a rational explanation of irrational changes in the economy in general, and in the banking system of the country in particular, come to the fore. Obvious becomes the need to identify completely different, new properties of the economic system, such as: dynamism, complexity, multivariate development and the reality of self-organizing processes.

The functioning of the banking system is a complex organizational and economic mechanism for the interaction of many interrelated entities – banks, first of all, which have their own targets. At the same time, all participants in the banking system together constitute an integral system in which the activities of each individual entity are aimed

at the joint fulfillment of a common task. So, the banking system is a structured, integral set of various forms of ownership, organization and nature of banking operations, historically formed on the basis of the country's legislation and is constantly transformed in accordance with the internal laws of development and external influences.

Using the category of system as the basis, let's consider it necessary to develop a categorical apparatus of the banking system features for a synergistic approach that provides for a deeper disclosure of the essence of such concepts as: complexity, dynamism and self-organization of the system.

The complexity concept of the system assumes that its constituent elements differ significantly from each other, but at the same time are conceptually similar. Therefore, locally, they can be random and deterministic in their generality. Today there are two ways in the study of complex systems, due to two different approaches. The first approach is associated with a generalized study of systems, and it is based on methods of analyzing systems. Such an approach is closely related to the general theory of systems and systems analysis, according to which «a complex system is a set of interrelated elements that form a certain integrity and unity, possess new qualities that are not inherent to these elements as separate components» [1]. This definition does not contain the concept of complexity and is common to various complex systems, without taking into account their differences.

«Complexity is a common property of a single set of different objects that are structurally interrelated, functionally interrelated and interact with each other ...» [2]. Consequently, the «complexity» concept is defined by scientists as an integral combination of structurally inhomogeneous parts without taking into account the qualitative definiteness of complex systems. According to this approach, the complexity of the system is identified with the concept of system integrity.

The insufficient depth and superficiality of studying a complex system can be traced in this position: «System theory investigates, in essence, a generalized model of a complex system that can't take into account the differences between complex systems and the differences between the complexity factors of real systems» [3]. In addition, the omission of the general theory of systems and the fact that the basic definition of an element as an indivisible component of the system does not specify the divisibility criterion, on which the type of elements and their number in the system depend. Also insufficient attention is paid to the differences in the links between the elements of the system.

The second approach is related to the study of complex systems as an independent research direction, has its continuation in the theory of complex systems (TCS), based on the choice of analogues of the system in biological, social systems. Developing the cybernetic approach of N. Wiener, who discovered the «law of necessary diversity», let's note that in complex systems there is an accumulation of a certain resource – «diversity». The author of this approach clarifies that this diversity is a behavioral response of the system, which should be more than the diversity of the problem, solved, or able to create (develop) in itself this diversity [4]. In the end, the conclusion is made about the self-organization of the system as a mandatory property.

The theory of N. Luhmann is rather interesting, which occupies an intermediate position between the classical theory of systems and the theory of dynamical systems and focuses on the differences between the system and the environment. The author of this theory for the definition of self-organization suggested a special term «autopoiesis», and the systems theory is based on the following pairwise principles [5]:

- complexity and rationality;
- reflection and self-reference;
- differentiation and communication;
- autopoiesis (self-organization).

Let's consider their essence in more detail. The main principle of the theory of N. Luhmann is complexity, and connects his theory with the theory of complex systems. Let's note that from this position the «complexity» category is a generalization of the «diversity» category [4]. The complexity of the system is associated with the following principle – rationality (reduction), which, to a greater extent, is interpreted as factors of development, the system should take into account in the context of the complexity of the relationship of the system with the external environment. The principles of reflection and self-reference are absent in the general theory of systems, but the author of the theory of N. Luhmann considers reflection as the information interaction of the system with the external environment, and the essence of self-reference reduces to self-identification (internal interaction of the system elements) [5]. As it is possible to see, this pair of principles describes and connects the internal and external interactions in the system, as well as the interaction of the systems themselves.

Principles of differentiation and communication also complement each other. In this case, the essence of communication is considered in the context of system management [7]. Functional differentiation is interpreted as the separation of parts of the system and the differentiation of relations between the system and the external environment [5].

The most important principle is considered to be the principle of the autopoiesis, which does not have its own pair, because it combines all the previous principles of the functioning of a complex system. As already noted autopoiesis involves self-organization and self-reproduction of the system and is considered an important category of the system paradigm [5]. Therefore, the theory of N. Luhmann can be applied in the study of any complex systems.

The relationship between the complexity of the system and its disorder is monitored in this position: «Complexity acts as disorder only in relation to the order whose existence we seek to decipher, that is, complexity is an invisible disorder, the existence of which gives reasons to assume the presence of a hidden order. The complexity of the system provides for our understanding of the structure of the global view, and at the same time, this view does not give us the opportunity to know its perfection» [6]. So, according to this interpretation of the essence of complexity, complex economic systems are considered as disordered systems.

Even deeper, the essence of the complexity of the systems is taking into account the transitional stage of dynamic development of systems. «One of the essential features of a complex process is the ability to make transitions between different modes» [8]. From this position it becomes obvious that according to the principles of functional complexity, only transitional systems can

develop, constitute the prehistory of the new, realize their potential through the mechanisms of bifurcation and chaos. Therefore, complex systems are systems that are able to realize their constructive potential through the mechanism of bifurcation and chaos.

It is also advisable to note that the concept of the complex is organically intertwined with the specifics of dissipative systems, the functioning of which is based on the principles of the irreversibility of the development of processes (the possibilities of reverse development are excluded). It is worth noting that the dissipativity concept of a structure is the conceptual foundation of the theory of complex systems. A dissipative structure is a space-time structure whose stable characteristics are determined by a sufficient influx of energy from the outside and the ability to dissipate, that is, the ability to dissipate energy into the environment [9].

Investigating the essence of complexity, it is necessary to take into account the fact that a complex system cannot be explained in terms of Newtonian deterministic logic (event «*x*» gives rise to event «*y*»). Taking into account the experience of classical econometrics, economic systems were considered as equilibrium systems (with point attractors), despite the fact that from an empirical point of view this was not confirmed. Economic systems in practice are characterized by non-periodic cycles, characterized by largely dynamic, nonlinear complex systems.

On this occasion, it is aptly noted: «The genetics of the complexity of systems is based on the principles of spontaneity, probability and instability» [8]. Therefore, complex systems are not just dynamic systems, the state of which is constantly changing in accordance with the influence of various factors, they are also non-equilibrium, the methodology for the study of which should be based on the principles of probability. Therefore, complexity is «an integral part of the world of dynamical systems» [10]. The essence of the dynamism of the system should be considered in the light of the theory of dynamic systems, which is an integral part of the theory of complex systems. So, a dynamic system is such a system, the state of which is determined in advance by the rules of changing the parameters of the system [12]. This definition reflects the basic principles of the functioning of dynamic systems. It should be emphasized that only complex dynamic systems can evolve through self-organization, which is not inherent to complex technical and rigidly deterministic systems.

The methodological foundation for the study of complex dynamic systems is the theory of dynamic systems, which is based on nonlinear equations, through which it becomes possible to explain the functioning of such systems. An important characteristic of dynamic systems is their sensitive dependence on initial conditions: when an insignificant cause generates a significant effect that is difficult to respond to, it is generally not amenable to prediction and prediction. Therefore, non-equilibrium and unpredictability in the long-term period are inherent in dynamic systems, which are explained by two reasons:

- 1) presence of feedback system;
- 2) presence of the concept of critical levels.

In addition, the complexity of the dynamic system is determined by the degree of its nonlinearity. The property of nonlinearity is the disproportionate response of the banking system to changes in the internal and external environment. The modern development of information

technologies forms the connections that generate a multitude of nonlinearity and cause new opportunities in the form of bifurcations. The openness of the banking system is considered as a wide range of vertical and horizontal informational, economic, financial and other relations with the external environment. The dynamism of the banking system is determined by the fact that its structure, goals and relations between the elements are non-permanent, they change and evolve over time.

The complexity, as a special feature of the banking system, characterizes it as an economic system on one of its micro levels, due to the fact that:

- the banking system is a self-organized system in which processes of spontaneous ordering, the emergence and evolution of its elements (banks) arise as a result of open nonlinear processes of self-organization (consolidation);
- the banking system is an organized economic system, that is, the result of the conscious activity of people, aimed at achieving certain goals and objectives;
- evolutionary processes in the banking system occur at a much faster rate compared with the development processes of other economic systems in particular, and systems of wildlife in general;
- the banking system is an open system, since information, energy, and substance are exchanged with the external environment;
- the banking system is a socio-economic system organized by people, since only under the condition of active and purposeful activity of people are new organizational formations created in the banking environment.

The concept of self-organization was first introduced in 1947, and at the initial stages its nature was studied in the natural sciences. Self-organization is the process of ordering the elements of one level of a system at the expense of internal factors, without the specific influence of external factors. The result of this process is the emergence of an element of a new qualitative level. The exact definition is the following: «Self-organization is a process of ordering (spatial, temporal or spatial-temporal) environment in an open system due to the interaction of the many elements that form it» [13]. As it is possible to see, self-organization should be understood as the process by which the organization of a complex dynamic system is created, reproduced or improved. The essence of self-organizing processes is that there is a restructuring of existing ones with the simultaneous formation of new connections between the elements of the system [14]. A distinctive feature of these processes is purposeful and naturally spontaneous, because they are based on the interaction of the system with the environment, are autonomous and relatively independent of the environment itself.

In addition, there are three types of self-organization processes [15]:

- the first is connected with the spontaneous generation of the organization – a new integral system with its own specific laws;
- the second type is the processes by which the system is able to maintain a certain organizational level, subject to changes in internal and external conditions of functioning;
- the third type is due to the development of a system that is able to accumulate and use the past experience of its existence.

So, all the processes that occur in open nonlinear systems, inherent self-organization. An economic system is capable of self-organization when, without a specific external influence, it can acquire some spatial, temporal or functional structure.

The system can generate stationary and non-stationary dissipative structures. In turn, the dissipative structure «transforms» the energy of the system in a certain way and due to this, fundamentally new qualities of the system arise [16]. An important result of the interaction is also the fact that topologism (continuity and connectedness) is inherent in the system; therefore, it is not so much the power of the management impact that becomes its correct spatial organization. Consequently, the content and key vector of the evolution of a system is determined, first of all, by its own substantial nature, and the influence of external factors is primarily secondary. Of course, exceptions are possible – in such cases, external factors do not speed up or slow down the internal self-organization of the system, but fundamentally change its character. Then the system either transforms, retaining some continuity with its past state, or becomes qualitatively new. But, in any case, it remains dissipative, that is, such that it dissipates energy to the outside.

All the above applies to the banking system, in which the self-organization mechanism assumes the structural content of its institutions (banks) in the historically established stable rules of social interaction. Institutional self-organization of the banking system is defined as the process of striving for balance under the influence of feedback and, at the same time, as the process of reproducing adequate institutional structures under conditions of constant changes in the processes of regulation and balance. Therefore, in order to ensure the stability of the banking system, the inherent rules and coherent mechanisms that ensure a meaningful, harmonious movement of all components of the system in time, as well as coordination of their time parameters are of fundamental importance.

The banking system can be considered as an adaptive system, since the existing process of passive and active adaptation of its elements (banks) to changes in environmental conditions. It should be noted that the adaptation degree of the system may be different. As studies show, the less regulated is the structure of the system, the higher is its ability to effectively adapt to the real conditions of functioning [17].

Thus, let's note: the banking system is an economic system, which refers to the type of complex, open objects, which are characterized by signs of dynamism, disequilibrium and self-organization. Its functioning in modern conditions of the market development can be described by integration, thermodynamic parameters, fully reflect the exchange of material and financial resources with the environment. At the same time, the complexity of the system is determined by the degree of its openness and nonlinearity, which will be the subject of further research by the author of this work.

## **7. SWOT analysis of research results**

*Strengths.* The strengths lie in the fact that the implementation of a synergistic approach allows the discovery of universal principles of evolution and self-organization of complex systems of any origin, including the banking

system. So, the proposed features allow to characterize the banking system as an open, complex, dynamic system, has a large number of elements and subsystems, and is in a state of instability, that is, a state far from equilibrium. Compared with the system approach, the proposed study allows to form the vision of the banking system as a complex, dynamic, non-equilibrium economic system capable of self-organization based on the nonlinearity of the links of its elements and non-equilibrium conditions of development.

*Weaknesses.* The analysis of theoretical approaches in the study of the synergistic characteristics of the banking system shows that the presence of an infinite number of possible solutions and independent of the time factor feedback mechanisms are its main identifying features. Considered properties will be inherent in the banking system only under the condition that it is not in equilibrium and capable of self-development and self-organization. The weak side of the proposed approach is the complex realization by the banking system of its potential, taking into account certain principles of functional complexity through the mechanisms of bifurcation and chaos, which today still requires in-depth research. In addition, it is necessary to take into account that chaos is a force that is capable of leading the system to self-organization, and is also a means of harmonizing the development of complex economic systems, just like the banking system.

*Opportunities.* It should be noted that for the formation of a comprehensive vision of the essence of the banking system from the standpoint of a synergistic approach, it is necessary to investigate such features as: openness, nonlinearity, coherence, adaptability. It is this vision of the features of the banking system that simplifies the understanding of the emergence of synergies in the self-organization of banks.

*Threats.* The threats to the functioning of the banking system as a complex economic system should be attributed to the fact that complex systems can't impose development paths; on the contrary, it is only necessary to promote their own tendencies and vectors of coevolution. For the banking system there may be several alternative development paths, the choice of which requires scientific substantiation based on the principles of synergetic methodology.

## **8. Conclusions**

1. The positions of scientists regarding the interpretation of the essence of the concepts «complexity», «dynamism», «self-organization» as important characteristics of the modern economic system are considered. The economic content of these concepts as features of the banking system by the synergetic approach is highlighted. In particular, the banking system is an economic system, refers to the type of open, complex objects that can be described by integration, thermodynamic parameters, fully reflect the exchange of material and financial resources with the environment. It also differs by dynamism and non-equilibrium of its development.

2. Prerequisites and features of self-organizing processes in the banking system are defined. The self-organization of the banking system is the process by which an organization of a complex dynamic system is created or improved. The processes of self-organization can occur only in those systems that have a high level of complexity and a large number of elements, the links between which are

not strictly determined, but have a probabilistic nature. The dynamism of the processes of self-organization of the banking system contributes to the generation of its processes and constituent elements. Thus, the recognition of the fact that the modern banking system is a complex, dynamic economic system predetermines the need to take into account the scientific assumptions of chaos theory in further studies of the processes of its self-organization.

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*Tkachuk Natalia, PhD, Associate Professor, Department of Finance, Banking and Insurance, Higher State Educational Institution «Banking University», Kyiv, Ukraine, e-mail: [kamashik@ukr.net](mailto:kamashik@ukr.net), ORCID: <http://orcid.org/0000-0003-1947-7565>*